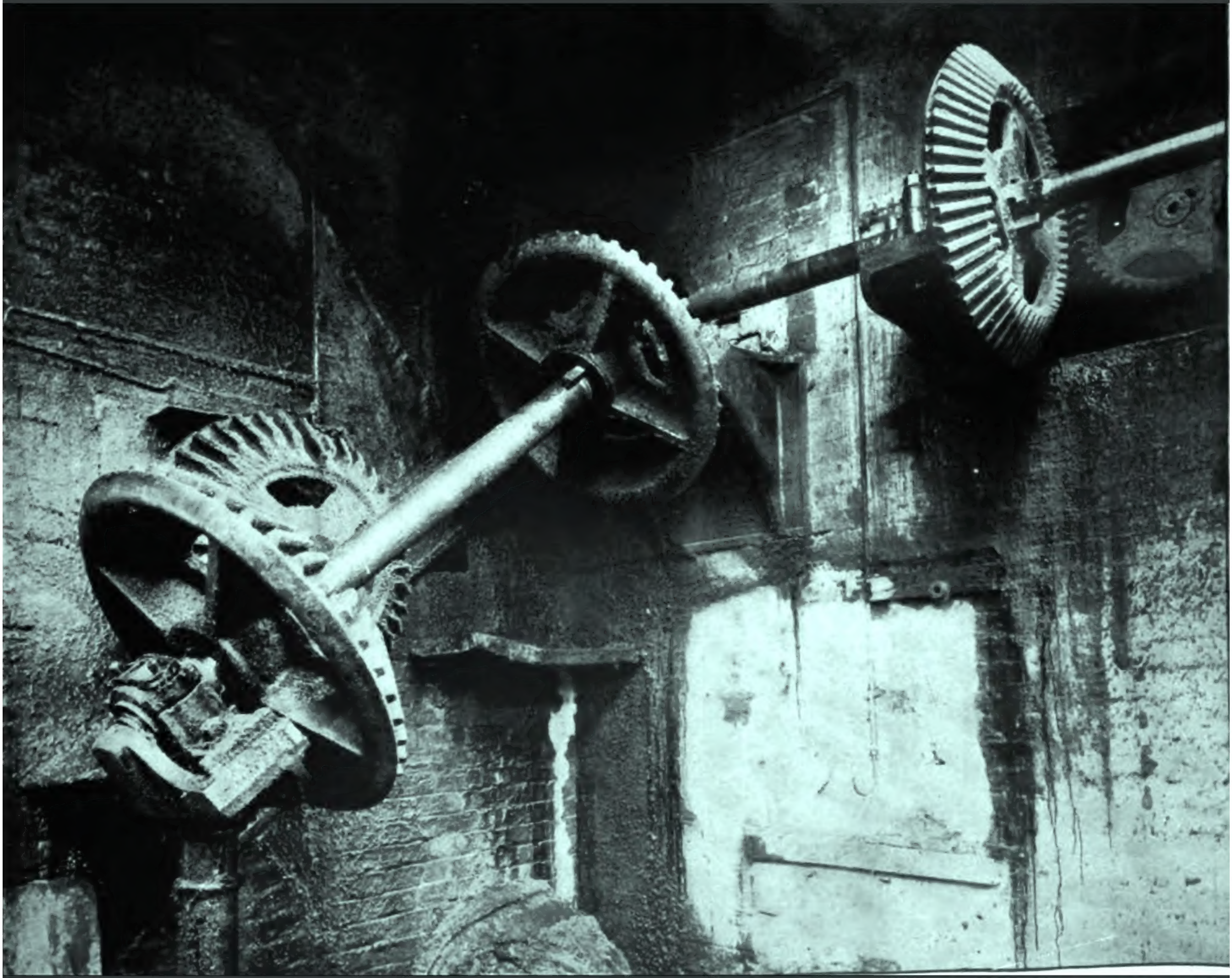

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The
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THEO. FEILDEN.

ACTING EDITOR:

E. DINSDALE PHILLIPS.

INDEX TO VOL. VIII.

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The World's Electric Progress.

Power.

Traction and Transport.

Central Station Practice.

Lighting and Heating.

Telegraphy and Telephony.

Electrical Design and Manufacture.

Electro-Chemistry, Electro-Physics, and Electro-Metallurgy.

Students' Section.

Manufacturing Progress.

Literary Section.

Electric Power in Textile Industries.

The Engineering and Machinery Exhibition at Olympia.

THE ELECTRICAL MAGAZINE

Second Edition.

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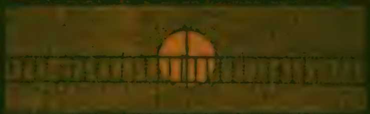

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Shakespeare

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By every mail we receive letters from the United States understamped, in many cases a 2-cent stamp being affixed only. We request American Firms to please instruct their Mailing Departments that the postage to England is 5 cents per ½oz. In consequence of the errors made on the other side, delay in delivery here is frequent, and the aggregate annual cost to "The Electrical Magazine" is somewhat heavy.

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To the Reader:

This is a Special Number of The ELECTRICAL MAGAZINE devoted to "Electric Power in Textile Industries." It forms the Second of an Industrial Series, the Special Numbers of which are to appear from time to time—each devoted to the use of Electricity in one specific Power-Requiring Industry.

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- *Electro-Chemistry, Electro-Physics and Electro-Metallurgy.*
- *Students' Section.*
- *Wiremen's Section.*
- *Manufacturing Progress.*
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The ELECTRICAL MAGAZINE is a veritable Electrical Review of Reviews, and as such is invaluable to all Engineers, Managers, Mill Owners, and others engaged in Manufacture.

☞ *Full particulars of the advantages secured by Annual Subscribers are detailed on last page of this issue.*

For LITERARY CONTENTS of this Number see page 6.

Buyers' Guide.

The display announcements of the respective firms incorporated under this heading can be quickly found by referring to the Alphabetical Index to Advertisers which follows.

Accumulators.
Pritchetts and Gold, Ltd., 20, Victoria Street, London, S.W.

Arc Lamps.
Arc Lamps, Ltd., St. Paul's Crescent, Camden Town, London, N.W.
Crompton and Co., Ltd., Salisbury House, London, E.C.
Electric & Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Reason Manufacturing Co., Ltd., Brighton.
Union Electric Co., Ltd., Park St., Southwark, London, S.E.

Artesian Wells.
John G. Thom, Patricroft, Manchester.

Belting.
James Hendry, Bridgeton, Glasgow.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Bobbins and Shuttles.
Wilson Bros. Bobbin Co., Ltd., Garston, Liverpool.

Boiler Accessories.
Alex. Turnbull and Co., Ltd., Bishopbriggs, Glasgow.
Winn, Charles, & Co., St. Thomas Works, Birmingham.

Boilers.
Babcock and Wilcox, Ltd., Oriel House, Farringdon Street, London, E.C.
Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead.
Richard Hornsby and Sons, Ltd., Grantham.
B. R. Rowland and Co., Ltd., Climax Works, Reddish.

Braiding Machines.
High Speed Braiding Machine Co., Ltd., Dame Agnes Street, Nottingham.

Cables.
Connolly Bros., Ltd., Blackley, Manchester.
India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd., 106, Cannon Street, London, E.C.; and Silvertown, E.
Simmonds Bros., Ltd., Newton Street, London, W.C.

Sole Makers of "Camel Hair" Belting.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Canvas Fire Hose.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Condensing Plant.
Mirrlees Watson Co., Ltd., Scotland Street, Glasgow.
Frank Pearn and Co., Ltd., West Gorton, Manchester.

Conduits.
Armorduct Manufacturing Co., Ltd., Farringdon Avenue, London, E.C.
Simplex Conduits, Ltd., Garrison Lane, Birmingham.

Controllers.
Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Frank Suter and Co., Ltd., 66, Berners Street, London, W.

Conveying and Elevating Plant.
Babcock and Wilcox, Ltd., Oriel House, Farringdon Street, E.C.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Conveyor Belts.
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Ed. Bennis and Co., Ltd., Little Hulton, Bolton.
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Craven Bros., Ltd., Osborne Street, Manchester, and at Reddish.
Temperley Transporter Co., 72, Bishopsgate Street Within, London, E.C.

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Meldrum Bros., Ltd., Timperley, Manchester.

Drills (Mining).
Armorduct Manufacturing Co., Ltd., Farringdon Avenue, London, E.C.
Corlett Electrical Engineering Co., Ltd., Wilcock Street, Wigan.
John Davis & Son (Derby), Ltd., 27, All Saints' Works, Derby.
Diamond Coal Cutter Co., Stennard Works, Wakefield.
Goodman Manufacturing Co., Ltd., Bank Buildings, St. Mary Street, Cardiff.
Hardy Patent Pick Co., Ltd., Sheffield

Dynamos and Motors.
British Electric Plant Co., Ltd., Alloa, N.B.
Crompton and Co., Ltd., Salisbury House, London, E.C.
Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Electromotors, Ltd., Openshaw, Manchester.
Frank Suter and Co., Ltd., 66, Berners Street, London, W.
General Electric Co., Ltd., 71, Queen Victoria Street, London E.C.
J. H. Holmes and Co., Newcastle-on-Tyne.
India-Rubber, Gutta-Percha, and Telegraph Works Co., Ltd. 106, Cannon Street, London, E.C.; and Silvertown, E.
Industrial Engineering and Motor Co., Ltd., 12, Exchange Street, Manchester.
Maschinenfabrik Oerlikon (G. Wüthrich), Oswaldestre House, Norfolk Street, Strand, London, W.C.
Mather & Platt, Ltd., Salford Iron Works, Manchester.
Newton Bros., Derby.
Sandycroft Foundry Co., Ltd., Chester.
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Thomas Parker Limited, Wolverhampton.
Phœnix Dynamo Mfg. Co., Ltd., Bradford, Yorks.
Rhodes Electrical Manufacturing Co., Ltd., Bradford.
Union Electric Co., Ltd., Park St., Southwark, London, S.E.

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E. Green and Son, Ltd., Wakefield.

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McGeoch, William, and Co., Ltd., 28, West Campbell Street, Glasgow.
Frank Suter and Co., Ltd., 66, Berners Street, London, W.

Electrical Equipment (Complete).
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Browett, Lindley and Co., Ltd., Patricroft, Manchester.
Campbell Gas Engine Co., Ltd., Halifax.
Cundall, Sons and Co., Ltd., Shipley, Yorks.
Diesel Engine Co., Ltd., 179, Queen Victoria Street, E.C.
Richard Hornsby and Sons, Ltd., Grantham.
James Howden and Co., Scotland Street, Glasgow.
Charles D. Phillips, Newport, Mon.

Engravers.
Press Etching Co., 12, Wine Office Court, Fleet Street, London, E.C.

Exhibition Fitters.
A. Elmes and Co., Upper Street, Islington, London, N.

Fans.
Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Electrical Supplies Co., 4, Southampton Row, London, W.C.
Electromotors Ltd., Openshaw, Manchester.
General Electric Co., Ltd., 71, Queen Victoria Street, London, E.C.

Fire Appliances.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Forced Draught.
James Howden and Co., Scotland Street, Glasgow.
Meldrum Bros., Ltd., Timperley, Manchester.

Friction Clutches.
David Bridge and Co., Mars Iron Works, Castleton, Manchester.

Fuse Boxes.
Reason Manufacturing Co., Ltd., Lewes Road, Brighton.

Buyers' Guide—*continued from page 2.*

Gas Power Plant.
Industrial Engineering and Motor Co., Ltd., 12, Exchange Street, Manchester.

Gearing.
George Angus and Co., Ltd., Newcastle-on-Tyne.
Buffoline Noiseless Gear Co., Ltd., Levenshulme, Manchester.
Hans Renold, Ltd., Progress Works, Manchester.

Generators.—See Dynamos and Motors.

Haulage Gears (Electric).
Corlett Electrical Engineering Co., Ltd., Wilcock Street, Wigan.
Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead-on-Tyne.
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F. Reddaway and Co., Ltd., Pendleton, Manchester.

Indicators.
Hannan and Buchanan, 75, Robertson Street, Glasgow.

Instruments (Electric).
Evershed and Vignoles, Ltd., Acton Lane Works, Chiswick, London, W.
Ferranti, Ltd., Hollinwood, Lancs.
Nalder Bros. and Thompson, Ltd., 34, Queen St., London, E.C.

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Connolly Bros., Ltd., Blackley, Manchester.

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A. E. G. English Manufacturing Co., Ltd., 4/5, New Compton Street, Charing Cross Road, London, W.C.
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General Electric Co., Ltd., 71, Queen Victoria Street, London, E.C.
William McGeoch and Co., Ltd., 28, West Campbell Street, Glasgow.
Frank Suter & Co., Ltd., 66, Berners Street, London, W.

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Wm. Sprowson and Co., Newton Heath, Manchester.
R. Waygood and Co., Ltd., Falmouth Road, Great Dover Street, London, S.E.

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John Holroyd & Co., Ltd., Milnrow, Lancs.
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Ed. Bennis and Co., Ltd., Little Hulton, Bolton.
Meldrum Bros., Ltd., Timperley, Manchester.

Medical Electric Appliances.
Dowsing Radiant Heat Co., Ltd., 24, Budge Row, London, E.C.

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Ferranti, Ltd., Hollinwood, Lancs.
The Reason Manufacturing Co., Ltd., Brighton.

Mining Tools.
Hardy Patent Pick Co., Ltd., Sheffield.

Motors.—See Dynamos and Motors.

Motor Starters and Regulators.
Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.

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Partridge and Cooper, Ltd., Fleet Street, London, E.C.
Stolzenberg Patent File Co., 50-53, Bishopsgate Street Without, London, E.C.

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F. Reddaway and Co., Ltd., Pendleton, Manchester
United States Metallic Packing Co. Ltd., Bradford.

Paper-makers' Cotton Drying Felts.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Patent Agents.
Bernhard Dukes, 1, Gt. James St., Bedford Row, London, W.C.

Printers.
London & County Printing Works, Drury Lane, London, W.C.

Printing and Washing Blankets.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Publishers.
The Electrical Publishing Co., Ltd., 4, Southampton Row, London, W.C.

Pumps and Pumping Machinery.
Crompton and Co., Ltd., Salisbury House, London Wall, E.C.
Edwards Air Pump Syndicate, Ltd., 3 and 5, Crown Court, Old Broad Street, E.C.
Mirrlees Watson Co., Ltd., Glasgow.
Frank Pearn and Co., Ltd., West Gorton, Manchester.
Ernest Scott and Mountain, Ltd., Newcastle-on-Tyne.

Ropes (Driving).
Thomas Hart, Blackburn.

Rubber-covered Bowls.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Scientific Instruments.
Crompton and Co., Ltd., Salisbury House, London, E.C.
John Davis and Son (Derby), Ltd., All Saints Works, Derby.
J. Halden & Co., 8, Albert Square, Manchester.

Screws.
Automatic Standard Screw Co., Church Street, Halifax.

Ship Lighting (Electric).
Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead.
J. H. Holmes and Co., Newcastle-on-Tyne.

"Sphincter-Grip" Armoured Hose.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Sprinklers.
Mather and Platt, Ltd., Salford Iron Works, Manchester.

Steam Traps, Separators.
Lancaster and Tonge, Ltd., Pendleton, Manchester.

Stokers.
Ed. Bennis & Co., Ltd., Little Hulton, Bolton, and 28, Victoria Street, London, S.W.
Meldrum Bros., Ltd., Timperley, Manchester.

Switches, Switchboards, &c.
Clarke, Chapman and Co., Ltd., Gateshead-on-Tyne.
Electric & Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Ferranti, Ltd., Hollinwood.
India-Rubber, Gutta-Percha, and Telegraph Works Co., Ltd., 106, Cannon Street, London, E.C.
McGeoch, William, and Co., Ltd., 28, West Campbell Street, Glasgow.
Nalder Bros. and Thompson, Ltd., 34, Queen St., London, E.C.
Switchgear Co., Ltd., Newhall Street, Birmingham.
Thames Iron Works, Shipbuilding and Engineering Co., Ltd., Canning Town, London, E.
Union Electric Co., Ltd., Park St., Southwark, London, S.E.

Textile Machinery and Accessories.
Asa Lees and Co., Ltd., Soho Iron Works, Oldham.
Wm. H. Bowker, Union Iron Works, West Gorton, Manchester.
Brooks and Doxey, Ltd, Union Iron Works, West Gorton, Manchester.
Cook and Co., 18, Exchange Street, Manchester.
Mather and Platt, Ltd., Salford Iron Works, Manchester.
Platt Bros. and Co., Ltd., Hartford Works, Oldham.
Joseph Stubbs, Mill Street Works, Ancoats, Manchester.
Tweedales and Smalley, Ltd., Castleton, near Manchester.

Tramway and Railway Equipment (Electric).
British Westinghouse Electric and Manufacturing Co., Ltd. Norfolk Street, Strand, W.C.
Mountain and Gibson, Ltd., Elton Fold Works, Bury, Lancs.
J. G. White and Co., Ltd., 22A, College Hill, Cannon Street, London, E.C.

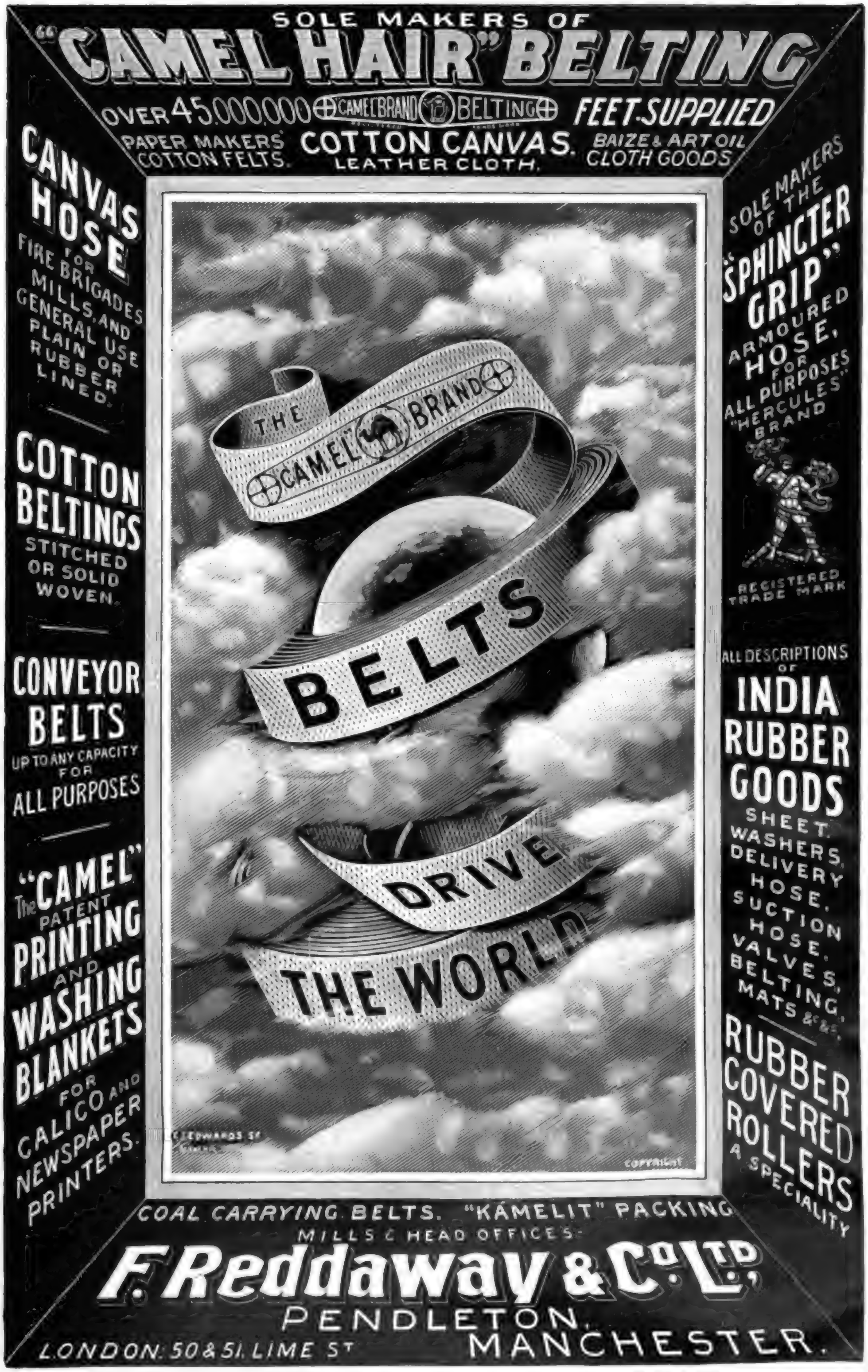
Transporters.
Temperley Transporter Co., 72, Bishopsgate Street Within, London E.C.

Tubes.
Stewarts and Lloyds, Ltd., Oswald Street, Glasgow.

Watches (Non-magnetic, &c.).
S. Smith and Son, 9, Strand, London, W.C.

Winches (Electric) and Speed Reducing Gears.
Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead.
R. G. Ross and Son, Glasgow.

Winding Engines.
Sandycroft Foundry Co., Ltd., Chester.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Index to Advertisers.

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LITERARY CONTENTS

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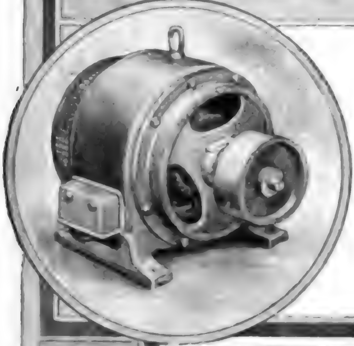

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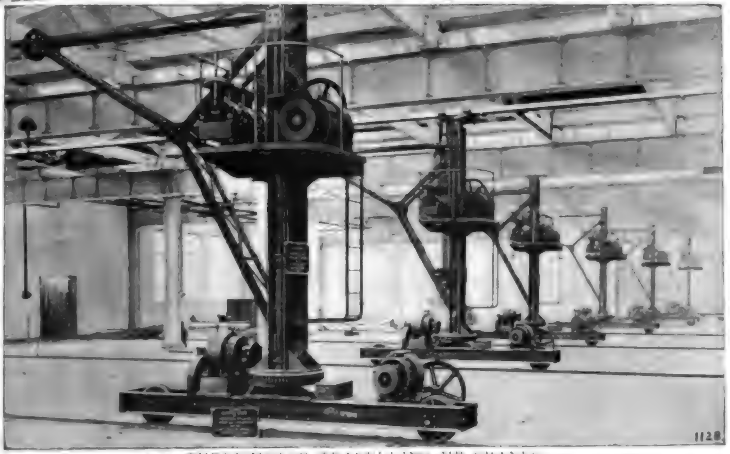
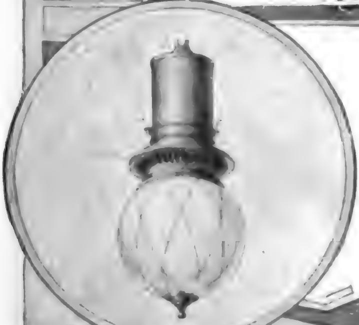


THREE-MOTOR TRAVELLING JIB CRANES.



ARC LAMPS, FLAME LAMPS,
PROJECTORS,
ELECTRIC CRANES, PUMPS
SWITCHBOARDS,
MEASURING INSTRUMENTS, &c.

1127

The attention of Readers of this Magazine is called to the Article on "LIGHTING" on Page 47.

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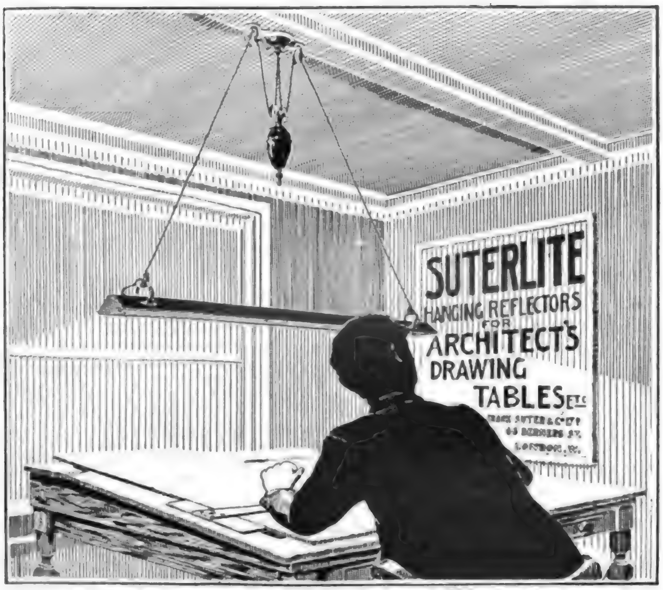

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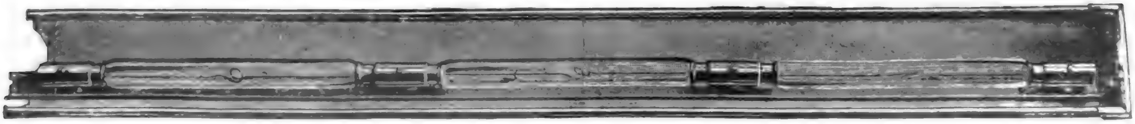


(43rd Issue.)

The Electrical Magazine.

FOUNDED AND EDITED BY
THEO. FEILDEN.

VOL. VIII. No. 1. LONDON. JULY 30th, 1907.

The World's Electric Progress.

About Ourselves. THE ELECTRICAL MAGAZINE with this issue enters upon its eighth volume, and in the coming December will have completed its fourth year. That we have accomplished much is best indicated by the steady progress and ever-increasing popularity of this journal which we are able to acknowledge.

It has throughout been our policy to keep fully abreast of the times. Not infrequently we have taken the lead in journalistic enterprise when public events, circumstances, and engineering development indicated the need. These efforts have always been attended with success, and each has considerably enhanced our reputation. The St. Louis International Exhibition, 1904; the 1905 Congress of the Incorporated Municipal Electrical Association; the International Electrical Exhibition, 1905; the British tour of the International Electrical Delegates of 1906; the Engineering and Machinery Exhibition, 1906; and several other epoch-marking events have been placed on permanent record in special numbers of THE ELECTRICAL MAGAZINE. These productions are acknowledged as the finest and most thorough treatments of their respective subjects.

With the beginning of this year we instituted a scheme whereby the progress of electrical work in the leading manufacturing trades would be fully entered into in a series of enlarged issues of THE ELECTRICAL MAGAZINE, each one of these numbers to be devoted to electrical practice in one specific industry, and to appear at such intervals as would allow of the obtention and careful selection of contents which would ensure the published result being as perfect and permanently valuable as possible.

The first of this Industrial Series appeared in March last; it dealt with electric power in collieries and its immediate success called for three editions. The fact that our Colliery Number now maintains a good rate of sale is proof of its value as a permanent work of reference.

The present issue of THE ELECTRICAL MAGAZINE not only introduces a new volume but it also forms the second of the Industrial Series. In selecting textile industries as meriting immediate treatment in a special number we were not prompted so much by what has already been done in the electrical equipment of textile factories—there are several other extensive fields of manufacture wherein electricity is much more generally adopted—but we chose the textile section mainly for the following reasons: It is one of the most extensive of all power-requiring industries; it has of recent years been exceptionally prosperous; new mills and extensions are the order of the day, and consequently now is the time to acquaint the textile man with facts regarding the advantages to be gained in his case by the proper use of electricity.

It will be noticed that we have endeavoured to cover the whole subject of "electricity in textile factories" in such a way that no phase of present practice has been neglected: cotton, wool, flax and jute; spinning, weaving, dyeing; engineering and commercial—all these branches of work and

issues have been included and discussed at such length as to appeal to the mill-owner and electrical engineer alike. We have tried to give such information as can be readily followed by the general reader; without being too technical, we believe that this collection of facts will carry the weight of conviction. Electricity is destined to be a ruling factor in the textile trade of this country.

The various articles have been specially prepared for this number by experts who were selected for the work as being experienced and practically engaged in the subjects of which each has written. Their opinions and facts can be accepted, therefore, as of the greatest value and reliability. One feature of this Special Number is the great use made of illustrations; our experience tells us that a well-chosen collection of photographs and drawings will often go further towards the telling of a convincing story than many yards of letterpress. A study of the engravings in this number will, of itself, be a very complete lesson in mechanical engineering, every form of electro-textile drive and installation being shown.

There is one feature to which attention should be drawn; we feel that our best thanks are due to those, and they are very many, of the textile and electrical and associated engineering manufacturers who have so cordially supported us in this work and who have assisted us by placing much information and data at our disposal.

The next Special Number of THE ELECTRICAL MAGAZINE is to have as its text the International Engineering and Machinery Exhibition which will occupy Olympia from September 19th to October 19th next.

It will be our endeavour to render the number of exceptional value by treating generally of the British engineering trade relations with the Colonies. We feel that such a publication would be of the greatest benefit to manufacturer and user, and indeed to all English-speaking people; doubtless our readers will welcome this movement and accord it their further and full support.

Electro-Textile Engineering.

THE employment of electric power for driving textile mills is growing daily in spite of the strenuous opposition and conservative feelings which have to be contended with. The position of the average mill manager is quite understandable. For a great number of years he has been conversant with the steam drive and no other, so that it is not to be wondered at that before accepting a power of which he knows little he should want definite proofs of the advantages to be gained. Unfortunately there have been failures in attempting to drive mills by electricity, and although such failures have been more than overshadowed by the great number of successes, the taste still remains, to the retardation of progress. Great advancement has been made, while a more perfect understanding of the conditions prevailing is displayed at the present time by the electrical engineer. Electricity as a motive power has certainly to be reckoned with, and its slow but sure adoption is to be noted throughout the world's textile mills.

There can be no gainsaying the fact that a much steadier drive is obtained by the use of motors either coupled direct to the various machines or driving the line-shafts. Steadiness saves excessive wear and tear of the machine, but quite beyond this in importance and value is the regularity of the yarn spun and the increased production which results. When it is considered that 7 per cent. increase in speed can be obtained by the employment of the electric drive and the result of the increase calculated for twelve months, the figures representing the capital outlay for the improved method bear a very different aspect. It has been stated that cotton machinery cannot stand the sudden start that arises when motors are coupled direct to them. In every case that presents itself to-day we find that suitable provision has been made to meet this point and that the frame need not be started at its highest speed.

The cost of current is a point upon which steam engineers lay considerable stress. It is well known that power can be produced extremely cheaply in a modern steam-driven mill, but it is strongly contended that electricity can be produced quite as cheaply even when expensive generating plant is installed. An expert as regards cotton spinning gives it as his opinion that current will have to be purchased at $\frac{3}{8}$d. per unit in order to enable electricity to compete successfully with steam. What would he say to 0.263d. per unit, or approximately an $\frac{1}{8}$d. less, and moreover the electricity being generated at

the mill itself so that capital charges, depreciation, &c., have to be considered? When due and proper care is taken in considering the individual mill there can be no doubt that results equal to if not better than those obtained from steam power can be got by the employment of electricity. Adaptability is recognized and considered as a valuable asset of the electric drive.

As regards the loss of efficiency stated to be due to transmission. The mill manager considers himself lucky if he gets off with a loss in transmission of 20 per cent. The loss of efficiency debited against an electric drive is only from 17 to 18 per cent. Without labouring the point it can safely be said that electricity has come to stay. For mill driving it possesses many advantageous features, and now that it has been proved beyond any possibility of doubt that the cost to produce the power compares very favourably with the cost to produce the power in steam-driven mills, rapid developments in the electric driving of textile factories will be made. Its recognised steadiness is invaluable in spinning fine yarns; its adaptability is extremely useful in certain cases, and a further point which has not been generally considered is that the cost of construction of new mills is materially reduced, while lighter and more airy rooms are obtained.

A Plain Talk to the Manufacturer.

HAVING no desire to belittle the merits and capabilities of our manufacturers or to deprecate their honest efforts to promote trade—as some papers are in the habit of doing—we feel still that there are certain things which it is necessary should be persistently brought home to them in their own interests. Of course we are chiefly concerned with manufacturers of electric plant and apparatus, and if anything we say now or at any time has the savour of unpleasantness we would remind our readers that a little wholesome criticism and advice is not a bad thing and that we are prompted solely by feelings and intentions which make for the good of our countrymen.

With this preliminary we may say that constantly we are having brought to our notice by intending buyers abroad the fact that the prices of British electrical goods are set down in the pounds, shillings and pence of this realm with no equivalents shown in the coinage of the country which is approached for business; the same is true of the units of weights and dimensions. Time after time has it been pointed out to our manufacturers what a handicap this is to British trade. Time after time have our manufacturers ignored this. We regret that many of them, with that insular prejudice which is their characteristic, have maintained that it is only necessary in their dealings with prospective foreign customers to quote prices, &c., in our own figures, assuming, we surmise, that the mere fact of the goods being British-made will make our friends abroad eager to translate the figures into the local equivalent and send their order here. What a mistake!—a mistake which has meant to this country the loss of many hundreds of thousands of pounds of trade.

Very different was it when Britain was the workshop of the world. We have now to reckon with other forces, strong, effective, calculating, aggressive. The foreign manufacturer invariably gives each country, whose merchants and buyers he is addressing, the figures of his offer in the units of that country. The intending purchaser can immediately grasp the most important factor, the price, and this, needless to say, facilitates business operations and more often than not leads to the foreign competitor securing the order which would otherwise have come to Great Britain.

Even if, as one of our contemporaries recently pointed out, it might be considered impracticable for the business men of England to-day to immediately change the character of their calculations, surely the metric system ought to be taught in our schools by legal enactment in order that a decade or two hence it would as a natural outcome have become the accepted method of calculation for the rising and future generations of British business men. That is, of course, if practice introduced more and more the use of metric measures. Until, however, the much-to-be-hoped for international uniformity of commercial units is a *fait accompli*, there are unquestionably the strongest reasons for manufacturers one and all going to the trouble when sending out their price-lists and catalogues from this country, of placing before the prospective foreign buyer the figures he most readily understands. We are glad to observe that a number of British houses now do this, but there are very many who do not.

We hope we shall not be accused of being pro-German or pro-American or pro anything except pro-British when we voice the opinion that our two greatest trade competitors are far-and-away in advance of this country both in regard to the way in which they explain the values of their products to foreigners and also in respect to the newer methods they employ in fostering and promoting trade relations. Their advertisements, no matter in what form, are better "business-pullers" than those sent out by the average British manufacturer, and whilst we do not hold with *all* our foreign rivals' methods—some in fact it would be impossible for us to follow and still retain that name for honesty of purpose and business integrity which British manufacturers have created and enjoy throughout the world—we most emphatically say that many of our ways can be improved upon, and that our merchants should not be slow to study closely and to follow wherever practicable such systems as the foreign manufacturers have proved successful in securing trade.

Whatever the value of the personal representative, it is an undoubted fact that the manufacturers of the United States have sown the seeds of immense business by the "catch-on" methods of publicity they have adopted and the "follow-up" literature which keeps their names and specialities in one form or another right before the man they desire to impress in each business establishment approached. The potentialities of a proper business system for extending trade are enormous. The bigger houses in the States employ a publicity specialist, and even in the smaller houses one member of the firm or head of a department has certain duties relegated to him in this connection which bring him in touch all the time with the most up-to-date methods of generating business for his house. In England, too much is taken for granted by manufacturers. They have their travellers out, they attend 'Change, they bring out a new catalogue or price-list, or send out some circulars as the fit takes them or as they think there is occasion, they have a few advertisements in certain trade papers, and so on; but they do not put that intelligent interest into their publicity department which is essential.

We are glad to see, however, that a number of representative electrical firms already have an organised Publicity Department, but here in several cases they have a lot to learn. This is where they should seek the aid of those who are capable and willing to help them. The efforts of the technical press to promote the business of our manufacturers are not always selfish and in the direction of obtaining an ultimate advertisement, but honest attempts are made by leading papers representing specific industries to forward business in various ways with a view to the general benefit of the trade. Of course the existence of a technical journal depends absolutely upon the prosperity of the particular industry with which it deals; the strange part of the matter is that the manufacturer does not seem to understand this fact, otherwise he would surely exhibit a livelier interest in the steps taken by the technical paper to advance his interests.

With the same spirit of conservatism this country has up till now treated the matter of tariff reform with a degree of intolerance which is truly remarkable. Whatever the merits or demerits of the movement it most unquestionably deserves the very closest consideration of all men who not only desire to continue an expansion of their business, but who value the future of this great Empire. Up to now the matter has been treated in the main as a political question. It should without doubt be eliminated entirely from this category. It is, or should be, an Imperial matter, as its adoption or otherwise is fraught with the gravest possible consequences for British traders, whatever their political opinions, and to everyone whose interests are bound up in the prosperity and welfare of the nation and of the great colonies and dependencies who owe allegiance to the mother country. We here frankly confess that we are distinctly and absolutely in favour of some measure of tariff reform in the absence of universal free trade, and that in our opinion, properly and judiciously applied, it would bring a degree of prosperity to the manufacturers and therefore to the workmen of this country unparalleled in its history; further, that in the absence of its adoption in some form or other Great Britain's manufacturers will become increasingly handicapped in the race for foreign trade, and that only the loyalty and sagacity of our colonies will enable this

nation to keep in the forefront of the world's largest producers. Then there is the question to face as to whether sooner or later the colonies will not one by one break away and in their own material interest be able to make better terms with our competitors than with the mother country. We are not biased; there are claims advanced by certain tariff reformers which we look at askance and which require very careful handling, but so long as the competing nations set up a wall of tariffs against this country, increasing them as they are doing in height and intensity year by year, so long as we have no effective means of making a bargain with them, so long will Great Britain continue to become, in proportion to other nations, less and less of a manufacturing country and more and more of an importing country. This state of things cannot go on for ever, and the pity of it is that the question is not more impartially considered.

This is not a new doctrine with us. We have not been and are not led by any party feeling. Let us say at once we are non-partisans as far as politics are concerned, absolutely. The Editor of this paper was one of the first to sound the keynote of Tariff Reform in a series of articles in an important daily paper some seven or eight years ago, which articles were the outcome of some years of patient research and investigation in regard to the trade and business conditions of other countries. It is for our manufacturers to keep the questions advanced herein before their eyes and not to let old-fashioned methods and time-honoured shibboleths stand in the way of progress and reform; otherwise the day will come, perhaps too late, when a rude and bitter awakening will take place.

The Incorporated Municipal Electrical Association.

THE twelfth annual convention of this Association was held in Sheffield, on the 25th to 28th days of June. Some 300 members and visitors were assembled. and received cordial treatment at the hands of the city authorities. As is general at these renowned meetings of the borough electrical engineer with his confrère, or shall we say master, of the committee, there was a full blending of the holiday outing with serious business. Regarding the latter, which after all is the part having the more permanent interest, there was very much to merit our notice at some length; we can, however, only deal briefly at this writing with the general tenor of the business done, reserving for a future issue a more detailed account of the purely technical papers read and discussed.

Turning to the annual report it is noticed that there has been a slight falling off in the number of members; the decrease is principally in the class of associates, which class is composed of assistant municipal engineers. The feeling of the Council anent this is presented in a General Statement which concludes their report. Commenting on the increased scope of the Association as following the increase in the number of local authorities owning electric systems, it is pointed out how essential it is that every rate-owned supply should be represented in the Association both by its engineer and its committee—this in order that the best work can be done by the Association. For those eligible for membership who withhold their support, and for indifferent backsliders, a little sermon is read in conclusion:

"It is only by concerted action that the interests of the community can be served and protected, and such action can only be effectively taken if backed up by the personal adherence of those on whose behalf it is sought to institute reforms or obtain concessions."

"It is not so much a question of personal benefit to the engineer or member of committee as of the advantage to be derived by the community through the Association as a body being placed in a position to deal effectively with such matters as concern the general welfare of municipal electrical undertakings."

The distinction between the "personal" and the "community" is not very clearly drawn in this peroration; however, we are not to criticise in that sense. In this case as in all others it is a matter of *personal* benefit. Do not men, even when co-operating in any matter or business, do so each for his own benefit? In the case of the I.M.E.A. there can be no doubt as to its great worth to the individual member, and as such the Association should as a matter of mere common-sense be accorded the whole-hearted support of every engineer and committee having control of municipal electric supply matters. If for no other reason this membership is demanded as a means of bringing employer and employed into close touch, to compare notes, to air grievances, in short to know each other in the real

business sense, and thus primarily to their mutual benefit and incidentally to the good of the industry in general.

For example, we have only to turn to the presidential address as delivered by Mr. Fedden, Sheffield's enterprising leader of the public electricity system. The following is a brief abstract from what was throughout a notable, straightforward speech. Mr. Fedden expressed the opinion that the importance of the Association and the great value of the work it had done were not sufficiently appreciated either by engineers or committees. He wished to impress the fact that the Association is quietly carrying out a great deal of work, and that it "has been able to effect improvements in various matters touching the electrical industry from the municipal electrical engineer's point of view, and to remove difficulties and grievances which would have been well-nigh impossible by individual effort."

After this Mr. Fedden expressed his opinions and judgment upon many matters which were entirely as between engineer and committee—matters which when brought into full daylight at a convention are relieved of the personal air of office or committee-room, and are duly weighed to the advantage and advancement of both parties concerned.

"It is now realised that the successful public supply of electrical energy is an undertaking to which the best class of technical and business men may entirely devote themselves and achieve results fully justifying a generous scale of remuneration and the fullest confidence on the part of the directing committee. The question of salary in the case of chief officials is one which seems always to arouse a great deal of discussion. Everyone interested in local government seeks economical working, and sees in the amount of a man's salary an item of expenditure which he frequently understands better than the estimates for works to be carried through under that man's supervision, although he probably realises that the clearness or otherwise of an official's judgment may make a considerable difference to the benefits to be obtained from the large expenditure which he is called upon from time to time to approve of."

"There is a feeling in the minds of many that it is not well for the control of so many public utilities to fall into the hands of officials. The increase in the number and importance of municipal officials is only a consequence of the increased scope of corporation activities, which has at least the sanction of the electorate, and in the newer branches of corporation work men frequently enter its ranks from private business, and again leave it for the often superior inducements of service with a private firm. They often have no monopoly to administer, but must compete with private trades having greater liberty of action, and can only succeed by giving the best possible service to the public, unhampered by any restrictions beyond those essential to the equal and fair treatment of every member of the community. The view taken by different parties on the influence and remuneration of public officials depends, of course, to a large extent upon their attitude towards the principle of municipal trading. And those who favour it, or have at least given attention to the subject, realise that the magnitude of the various undertakings controlled by municipalities to-day calls for the keen supervision and directing initiative which characterises the management of the best class of private business, and the salaries for which, at first sight considerable, may easily prove to be the best of investments and yield a good return in a satisfactory and economical service."

Regarding the treatment of the engineer by his committee, the speaker went on to say that during the whole of the period he had been in municipal employ he had received the utmost consideration, courtesy, and support from those members of the council who have had the direction of his department.

"Unfortunately, however, this is not always the case, and instances are on record where municipal engineers have been placed in ignominious positions because of the unnecessary interference of committees with the technical details of the undertaking. It cannot be expected that the average committeeman can often be in a position to decide matters of a technical nature, and after giving the fullest consideration to the question of general policy and expenditure advanced by the managing engineer, it is far better that all technical and detailed matters should be left in the hands of the man who has spent years in acquiring knowledge and experience of this work. The broad questions of general policy and the commercial development of the undertaking are matters worthy of the close attention and delibera-

tion of committeemen, and in this direction some of them have notably advanced the interests of their departments and the electrical industry generally.

"The continuity of the chairman and principal members of committees is essential to the successful development and well-being of the department, particularly so in the case of an electric supply, where the intricacies of working cannot be grasped in a short time, but can only be gained gradually by actual experience. Therefore it may happen that at the time when a chairman is compelled to relinquish his office he has become fully capable of efficiently guiding and controlling the electrical enterprise of the corporation, which would, by reason of its complexity, be left entirely to the official in charge unless the principal members of the controlling committee were prepared to devote some time and attention to mastering the principles which underlie its successful working. The advocates of the 'short-period' policy would probably say that the control of the department does not rest with the chairman, but is in the hands of the committee. But as a matter of fact the committee is largely guided by its chairman and those members who act as chairmen of sub-committees, for the simple reason that by virtue of their offices they have familiarized themselves with the details of the administration of the department in a much greater degree than the other members of the committee are able to, and are, therefore, better able to explain matters relating to the working of the department and advise the committee accordingly. Under existing arrangements there is always the risk that the policy of the department may be interrupted by a change of the party in power, and although it does not necessarily follow that the installation of a new chairman denotes a discontinuance of the policy adopted, yet it may often react unfavourably upon the undertaking, inasmuch as the change will generally necessitate a considerable amount of work on the part of the engineer in order to put the new committee properly in possession of information which is essential to their appreciation of his schemes and requests.

"If a short period of office is wrong in the case of the chairman, how much more so is it with the managing engineer, and in this direction there is satisfaction in noting a great change in recent years. The industry and the individual departments are gainers by the change, for the prospect of a long tenure has a steadying effect upon a man's work and policy, and promotes a feeling of security among the rank and file of the staff. It must not, however, be thought that too great a devotion to any particular berth on the part of the young man is recommended. On the contrary, after completion of the pupilage or apprenticeship or whatever probationary time he has spent in finding out what he wants to learn, the young engineer should take the earliest opportunity of getting experience in other parts of the country or abroad, for as years pass it becomes more difficult to make such changes without sacrifices of salary or social ties, and in later life when money is an object and more important positions are to be sought, these early experiences will generally bear fruit in attributes of character and personality of the greatest value to a leader, and an appreciation of the futility of any dogmatic attitude towards technical problems, qualities not often found in those whose early experience, although perhaps deep, is possibly narrow with regard to places and people.

"A question which has been the subject of some discussion is the division of the management of an electric supply business into two departments—an engineering and a commercial. Although the circumstances vary to some extent with local conditions and the relative proportion which the engineering side bears to the commercial in different undertakings, such a business should be under the control of an engineer who is qualified by temperament, education and experience to watch and foster its commercial development whilst well able to carry forward the engineering work and deal with the various problems of supply. I· must be borne in mind that the development of electrical engineering has led to so much specialization on the part of manufacturers of machinery and apparatus that it is no longer necessary or possible for the purchasing engineer to be an expert in the design of all the machines he uses; a sound engineering training and the assistance of men who have had considerable experience in their own different branches of electricity supply work will enable him to expend capital to the best advantage, and design the whole of his system with a unity of object which would hardly be attainable by a man who had not been trained to regard the

business from the broad standpoint of a reliable and cheap service with sound, if not highly profitable, financial results. The whole business of the supply department should be carried out by the engineer manager. There have been some attempts to combine certain duties, such as account collecting, with the rates and other demands made from the borough treasurer's office. This, at first sight, possesses certain advantages, but very little experience goes to prove it a dangerous policy, because the electricity department holds no real monopoly and has all to gain by keeping in close touch with its consumers, meeting their complaints promptly, and taking care to give them the feeling that it is ever ready to assist them to get actual value for the moneys paid, and not force them to pay whether pleased or not in the automatic and impersonal manner associated with rate collecting.

"Until quite recently electric supply undertakings did little or no advertising in the ordinary sense of the word. In the early days of electric lighting, as soon as the service became reasonably reliable in the large towns there was no lack of demand from public buildings and the better class of business and private houses, where the advantages of electricity as an illuminant against those of its then very imperfect rivals far outweighed considerations of cost. The engineers of that day were concerned with a host of technical problems which needed solution before the public supply of electrical energy could be developed freely, and had no leisure and little inclination to tackle the unaccustomed task of creating a demand for their commodity. So for a long time they were content with the return which the unworked ground provided. But the change in methods of business and living, calling every year for greater artificial comforts and mechanical aids, stimulated invention, and rendered it possible to extend greatly the scope of electrical work, and made it necessary to reduce the price of electrical energy in order to meet the competition of other sources of light and power to such low figures as could be only realized by production on a large scale. The object in view is to ensure that every likely consumer shall become acquainted with the possibilities of the supply in relation to his business, pleasure, or home life, and that such information shall certainly reach him without any effort on his part. The safest and most efficient means of securing this result is by demonstration in the form of Press records of work done, showroom displays, exhibitions, and the loan of apparatus on approval, and although this method may involve considerable outlay, the return would be immeasurably greater than upon any extensive scheme of general advertising alone; moreover, such means inspire confidence and avoid the possibility of creating an exaggerated impression, or overstating any particular claim. Apart from considerations of business morality, this is a most important point, where the investment by the consumer in electrical apparatus is not the end but only the commencement of continuous business relations, which can only be satisfactory and react favourably on the undertaking when the results are at least equal to the expectations of the purchaser."

Mr. Fedden's witty remarks anent a phase of electricity supply which has hardly yet received serious consideration, but which will doubtless be broached more often now that democracy and socialism are influencing municipal matters, are worth repetition.

"The possibility of doing away with electricity meters seems to have a fascination for many minds, and often one hears it remarked that electricity should be supplied like water, some charge being made based upon the value of the user's premises and the capacity of the consuming apparatus fitted therein. The most important distinction lies in the fact that there is so very little temptation to exceed a certain average consumption of water per individual. In spite of amateur gardeners and photographers, when the average man has been provided with water for his cooking, bath, and household requirements, with perhaps a little to drink for the benefit of his stomach, he has no incentive to use more. Water for him has reached its point of 'final utility,' in the language of the political economist, and further supplies would be worse than useless. But a supply of electrical energy convertible to so many purposes of use and luxury, or even profit-earning, would be a great temptation, and in spite of restrictive fuses and fittings, a rising load factor associated with falling profits would result, in contradiction to all experience. It has often been remarked in defence of municipal trading in wiring and fittings that cheap fittings sell electricity. Without the much-

abused meter cheap electricity would sell fittings, and profits would be sought in a boom in electric heaters and sundries."

The Commercial Development of Central Stations.

THE central station manager in this country is now fully alive to the need of commercial activity. He realises the immense benefit an efficient sales department has upon the output and profits of a public electricity supply system. The great search to-day is for knowledge of the detail of organising a really efficient business-getting department. There are a thousand and one ways of interesting a prospective customer to the point of an order; to discriminate and select for use such methods as are most economical and surely productive is not an easy matter. One thing is very certain in this connection — the Americans have taken thoroughly hold of the matter, the "new-business" phase of central station practice is the one important subject to the public supply company of the States. We have from time to time and often indicated to our readers the original schemes introduced into American practice —probably the most outstanding of which is that known as the Co-operative Electrical Development Association, of which full particulars were given in THE ELECTRICAL MAGAZINE of January, this year.

The work of this unique and obviously common-sense organization is producing great results, as was shown at the annual meeting of the National Electric Light Association (U.S.A.) held last month in Washington. The originator of the scheme and its moving spirit is a Mr. Crouse, and he presented a report on the work done and the trend of further development. He sketched the work of the representatives in the field, and outlined the plans for having representatives on a joint committee of electrical manufacturers, contractors, architects, builders, and the technical press. Co-operation is also had with advertising agencies, and a plan was advanced for the establishment of a national commercial press bureau. The results, as summarized from reports from 934 central stations, showed that many had organised new-business departments, engaged canvassers, started direct-by-mail advertising and newspaper advertising, increased advertising appropriation, opened up display and demonstration rooms, and hung out their own electric signs. This amounted in the aggregate, for 1906, to an expenditure of £181,530 ($871,347). With the reasonable assumption that it has been continued for the five months of 1907, it would now aggregate £257,170 ($1,234,408). Allowing forty-five cents as a liberal estimate of the cost of securing a 16c.p. equivalent of new or added business, this would result in 2,743,131 16c.p. equivalents, or 137,156.55-kw. As an indication of the probable gain through this service, it is stated that the gain in lamp sales for the country at large was five per cent. in 1904 over 1903, eight per cent. in 1905, twenty per cent. in 1906, and so far this year more than twenty-five per cent. over the corresponding period in 1906.

Many of the speakers at the Convention told of the almost surprising results of a forceful business-getting policy, so far as it entered into their work or came under their direct notice. In the opinion of one of these practical exponents of central-station development, the commercial age being already reached, each day the commercial end of the business assumes greater and greater importance. The aggressive work being done by many central stations has created a new standard of lighting, and while some central stations may do nothing themselves and still reap some benefit from the work of others, it is now possible for a small expenditure of money and effort on the part of each to bring splendid returns in the field of development of business. It is by the concerted effort of all central stations that the greatest development can be secured.

There is no reason why the central-station engineer should not take up new-business work if he chooses to do so, and feels that with the same qualifications he is better equipped to realise success than the man lacking in the special technical knowledge of the business. At the same time results prove that this work of central-station publicity calls for men of specialised training; such men must be, first and foremost, highly experienced in commercial routine; they must be particularly versed in the ins and outs of the science and practice of advertising; they must, moreover, have technical experience of applied electricity in all its phases.

There can be no doubt whatever that the success of the Co-operative Electrical Development Association is to be attributed solely to the efforts of its controlling experts. The central-station men of the States were

quick to see the advantages of this specialized labour, and are reaping the consequent benefits.

A speaker at the Convention told how he used to talk about the point of saturation, meaning that time when all the light and power sold was all that could possibly be sold in a given city. The saturation limit has not yet been found; but on the other hand, the longer commercial development of work is carried on, the more easily additional business is acquired and the more business there is still in sight. "Nothing succeeds like success."

In the face of the fact that 10s. ($2.50) per capita income from the sale of electric current was the average according to the last census, the fact develops that where central stations take up seriously and aggressively the new-business methods under discussion, the per capita sales have been and can be increased to £1 ($5.00), £1 15s. ($8.50), and even to £2 10s. ($12) per capita, in cities of all sizes and conditions.

The above figures were cited by another speaker who further summarised the results of the commercial departments of many central stations, indicating the following interesting facts:

First—That the per capita incomes in such stations rapidly pass the average of those where live, active interest is not taken in the commercial development.

Second—That expenditures of from 3 to 5 per cent., and even more, of gross income on business extension along proper lines is fully justified by the results. This percentage of expenditures, it will be noted, is very small as contrasted with more competitive lines of business.

Third—That the load-curve is very materially improved, and in consequence the ratio of gross income to operating expense.

Fourth—That central stations which have operated these commercial departments for two or three years, or even longer, do not, as at first might be expected, reach the point of business saturation, but continue to maintain the rate of increase through educating the public to higher standards of service and through the introduction of new devices and appliances.

Fifth—That aggressive commercial departments are the most important factors in the cultivation of improved relations with the public and have in numerous instances been worth to companies all they cost from this standpoint alone. The time will soon come—if, indeed, it is not already here—when the commercial engineer in his work of creating and extending central station business will be entitled to take equal rank and importance with the electrical and mechanical engineer in the perfection of his work of producing generating and distributing apparatus and the reduction of current cost. It would seem that the mechanical and electrical engineer should welcome the advent of the commercial engineer, since the efforts of the latter are directed to extending the field of operation of the former and toward introducing more largely the comforts, conveniences and benefits of the entire art.

Here again is evidence that these duties belong to a specially trained class of engineer—the commercial engineer.

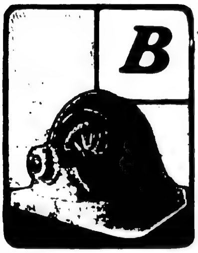
Further confirmation was given in another paper, the author expressing the conviction, founded on a long experience, that in any community where the seed has been sown, where an advertising campaign has been conducted along right lines and is being continued under adequate auspices and fairly favourable conditions, the advertising should be responsible for and produce, directly and indirectly, at least 60 per cent. of the business. To accomplish this result, however, there must be modern and progressive management on the part of the central station; and there must be the employment, in charge of the publicity department, not of an advertisement writer, but of an advertising man. These do not grow on every tree and are worth real money when found, but they can be secured if one is willing to pay the figures offered by other lines for ability, equipment and experience of this kind. In advertising, more than in almost any other department of business activity, it is a true and trenchant fact that cheap men are dear at any price.

Readers interested in the development of Central Station Business should communicate with The Electrical Publicity Bureau, 4, Southampton Row, London, W.C., which is an organization connected with THE ELECTRICAL MAGAZINE *and which is engaged in this specialised class of engineering development. Reports of work done and methods employed or recommended for particular districts will be supplied to any Central Station Authority desiring the information.*

Electric Power in Textile Industries.

ELECTRO-TEXTILE MATTERS IN GENERAL.

From the Electrical Point of View.



By way of introducing the subject of the use of electricity in connection with the manufacture of textile fabrics, it would be well to go generally over the ground, indicating why, in the first place, there is need for the electrical and textile engineers to join forces, and further what are the resultant benefits to be reasonably expected from such combination.

Textile work occupies a distinct position in the world of manufacture. Here is no handling or moulding of rough, heavy material where sheer strength and the most massive and tough machinery perform the best service; on the other hand, the materials worked are comparatively fragile, and to mould or work them to the best advantage requires the use of machines which are largely sensitive, speedy, and more or less delicate and definite in their operation. More than this, the materials require careful handling and treatment, not only by the manufacturing machines, but in intermediate processes and when finally placed on the market. Consequently, textile machines must be so constructed and driven as to be under the most definite and ready control at all speeds and under all conditions; and cleanliness, ample lighting and free space, are essential in the factory and warehouse.

The Electric Motor.

So far as the driving of textile machines is concerned, the merits of the electric motor for this service will be best indicated by citing properties which are common to all electric motors, and applying them generally to the case under notice.

Reliability—the most important of all factors in comparing manufacturing plant of any description. So far as the electric motor in textile work is concerned, one has only to consider that the motor which operates punches and shears in the open-air shipyards, drives pumps when totally immersed in water, cuts coal and hauls tubs over rough ground and steep gradients in the recesses of mines, handles huge white-hot billets in steel works, and so on—is the identical machine which is available for use in textile factories. For all the purposes mentioned the electric motor is used in hundreds of cases; it has therefore proved reliable under those adverse conditions, and surely the textile manufacturer need not inquire further for evidence in this direction. The electric motor is unaffected by the extremes of temperature, moisture, dirt, and inattention as met with in any industry. The textile industry does not introduce any of these extremes.

Wear-and-Tear and Depreciation.—The electric motor has frequently been spoken of as being as simple as a grindstone, and with

great truth. The only parts subject to wear are the two bearings. These are in every case of such liberal design that the rate of wear is insignificant, for the simple reason that the electric motor is essentially a machine designed with a small clearance between the rotating and fixed parts, and this clearance must be uniform and retained so. Consequently, the bearings of a motor are absolutely safe, their lubrication being in all cases automatic and ample. In the case of induction motors the bearings are the only rubbing parts, and wear-and-tear losses are practically nil. With direct-current motors, in addition to the bearings there is the commutator which is subject to wear; in high-grade motors this is of ample width and depth, and may be considered as good for ten to twenty years' service. The brushes which rest upon the commutator take the wear of this rubbing part. They may require renewing once or twice a year, but their cost is insignificant, perhaps only a few pence each. It may be taken, therefore, that wear-and-tear losses are far lower with the electric motor than with any other driving machine or mechanism.

Labour and Running Costs.—The lubrication being automatic, constant supervision of electric motors is unnecessary. As a rule, the oil in the bearings requires replenishing about once in every four or five weeks. The absence of moving mechanism reduces cleaning to a minimum, and even that consists merely of dusting at intervals. The oil, stores, and labour account is extremely low.

Space Occupied.—The size of an electric motor, for its power, is smaller than that of any other form of power machine, and by producing a direct rotary motion at a comparatively high speed any necessary mechanical transmission gear between the motor and the driven machine is small and light. Moreover, the electric motor, being small, and a balanced rotary machine requiring practically no supervision, can be safely fixed in any convenient position. Neither heavy foundations nor precautions against vibration are necessary; as a consequence the motor is frequently placed high up on a wall bracket or suspended from the ceiling. This arrangement is entirely one of advantage. The motor control, starting, stopping, and regulating, can be as readily effected with the motor far away from the controlling switch as alongside it; this is true whether the motor be hand-controlled or automatically operated. This feature of the electric motor introduces many unique advantages into textile factories.

Capacity of Mills.—The capacity of mills for productive plant is largely increased by the use of electric motors, which can be placed in out-of-the-way positions and transmit power to the textile machines by simple, small, and light mechanical transmissions.

Efficient Lighting.—Absence of a multitude of shaft lengths, pulleys, and belts renders the day lighting of a mill much more effective, and means economy and effectiveness with artificial lighting.

Hygienic Conditions.—The increased air space, more efficient lighting, reduction of noise, greater cleanliness, and increased sense of safety accompanying the use of electric motors, all make for the more healthy and happy condition of the textile worker. This feature is not of purely sentimental or social worth; it is a proved fact that the efficiency of the worker is greatly increased and the quality and quantity of the turn-out improved.

Flexibility of Mill Equipment.—Wherever electric power is introduced there is gained the maximum of flexibility for changes in, and expansions or reductions of, machinery. It should be noted that electrical driving permits of machines being located with respect to each other and the best lighting irrespective of shaft lengths, shape of mill, &c. Any number of machines may be used, according to whether trade be good or indifferent. Alterations and additions to plant can be effected quickly, at small cost, and without interfering in any way with the operation of the mill. This same feature also shows that any breakdown occurring will, when electric driving is used, affect the minimum quantity of plant, and that it is certainly the easiest and quickest to repair.

Economy in Power.—The electric motor is a machine whose power at any time can be measured absolutely and accurately. Consequently, the most efficient-sized motor can be installed for any duty, and a check can be readily kept upon the power cost and performance of any particular textile machine, appliance, or department. This is a most important feature, and a wide-awake mill manager has thus a means of working many very material economies. It must also be

remembered that a motor can be started and stopped with the greatest ease. There is no excuse for a motor running empty, and when it is stopped no power is being consumed. The efficiency of a motor on load is in any case very high and superior to any other power engine. Where the current is purchased from a public supply system the electricity bill is proportional to the amount of work turned out by the mill.

Steady Speeds and Exact Regulation.—The electric motor is essentially a constant-speed machine, and although the power demands of a textile machine may vary momentarily between wide limits, the speed of the machine will be kept constant owing to the flywheel effect of the high-speed balanced armature of the driving motor. Although the motor is a constant-speed machine, that speed can be varied at will; the operative can quickly adjust the speed to any definite value within wide limits with a precision that is impossible with any other form of driving unit. Thus the textile manufacturer can produce the best quality of work at the most rapid and economical rates. The operative is, moreover, independent of his fellows; his speed of working is not limited to that of a line-shaft set to suit the slowest worker, but he can turn out material in quantities proportional to his ability.

In thus setting forth the principal properties of the electric motor which bear more particularly upon its applications to the textile industry, no direct comparison with existing steam, rope, belt, shaft, pulley, and gear drives has been made. The object has been to enunciate clearly the vital facts, leaving the textile engineer, as he reads, to make comparisons based on his individual experience and knowledge.

The Electric Transmission.

Regarding the transmission or distribution of electric power, there is perhaps no occasion to point out its very obvious advantages. But it must be remembered that in textile factories the insulated wiring of the modern mill takes the place of rope races, long shaft lengths, vertical shafts, bevel gears, innumerable belts, &c. Realising this fact places the electric system, in so far as power transmission is concerned, so far superior to all other methods on every count as to preclude discussion. In first cost, convenience, power economy, running expenses, maintenance, small space, safety, isolation of floor and buildings, reduced risks of fire and breakdown, &c., the electric transmission possesses overwhelming advantages.

Where the electric current is purchased from a public supply company, motors and wiring form the essential parts of a complete power equipment.

In other cases, of course, an electric generating plant is necessary. The modern direct-coupled steam-driven generator has become standardized, and no particular experience is required for its operation beyond that possessed by the usual skilled engine-driver.

Choice of Generating Plant.

It may be taken that steam-driving for electric plant has become standard practice, and although the gas-engine as prime mover is deservedly receiving wide attention at the hands of power engineers, and has already been widely used in electrical power generation, there is not much progress to report in its adoption for use in the textile industry. The gas-engine maker has still to break down the old prejudice and persuade the prospective buyer that his engine has thoroughly proved itself in practice as having the even turning moment which he claims for it. No one doubts the economy of power-gas plant and the modern gas-engine; it is the most economical of all power-from-coal systems.

The desirability of absolutely constant cyclic speeds has led to the serious adoption of steam-turbines for electro-textile installations. With this type of plant there is certainly secured the steadiest running, but whether the superiority of the turbine in this direction over the modern high-speed reciprocating steam-engine or even the best types of gas engine, is so marked as to be of real importance, is doubtful; naturally, turbine builders hold one opinion, high-speed engine makers have the other, and those who build both or neither have no doubt that both types will supply current for textile work with equally satisfactory results so far as speed constancy is concerned. The textile manufacturer can have no difficulty here—either high-speed engines or turbines will introduce no speed troubles. For the comparison of these two forms of prime-movers in other directions there are volumes of evidence

available and to enter now into a full discussion of merit and demerit would mean a too lengthy writing. Reliability and economy are respectively the important features to the textile man in such a comparison. The excessive speed of the turbine does not make for the extreme of reliability, and when breakdown does occur (to which everything constructed and mechanical is subject) the damage is likely to be extensive and disastrous; the economy of the turbine is great—when its condenser outfit is in perfect working order. In such manner should the steam end of a generating set be compared. Referring to the electrical end it can be said that for alternate-current work points are equal; for direct-current work the advantage rests with the reciprocating set.

Alternate-Current or Direct-Current.

There is not a great deal to be said in comparing for textile factory service the alternate-current and direct-current systems. Either will give perfect results. The time has not yet arrived when single-phase power work can be seriously considered, consequently only three-phase and two-phase alternating current enters the question. With the former, three separate conductors are required for each transmission main; with the latter, four conductors per main; direct current requires but two conductors. True the total weight of copper in the conductors in the systems differs, but such difference in its effect on the cost of a complete equipment is practically negligible. Switchgear, &c., must also be two-pole, three-pole, or four-pole, according as to whether direct-current, three-phase, or two-phase is used.

In the power house, where plant is under constant skilled supervision, there is nothing of great consequence to choose between the two classes of installation. In the mill the alternate-current motor has the advantages of increased simplicity, lower maintenance and attendance charges, and of course greater reliability, owing to the facts that the alternate-current motor has neither commutator nor brush gear and that its rotating part does not include a highly-insulated wound armature. These remarks are entirely true for non-slip-ring alternate-current motors; in those cases where, for reasons of gradual starting under load or exceptional speed regulation, it is advisable to use slip-ring alternate-current motors, the comparison still holds good, though to a less extent. Slip-rings are not liable to sparking or to any considerable wear, the wound rotor is not connected to the main current supply, and the current it carries is only of low pressure and does not necessitate a high degree of insulation.

In point of efficiency also the service of textile mill driving is particularly suitable for the alternate-current motor because steady loads and speeds and continuous running are the rule.

For the lighting circuits where incandescent lamps are used either direct current or alternating current may be used with equally good results; for arc lighting, direct current, and for the new "tube" lights alternate current, are preferable.

Electric Lighting.

Whether electric power is used or not, the electric light should be adopted in every textile mill if only for the reasons that fire risks are minimised, that the light centres can be brought right down to the machine and concentrated upon the work, and that colours can be perfectly matched. The general advantages of electric lighting are too well known to call for further mention, but the points mentioned are of vital importance in textile mills and warehouses.

There are many other electro-textile matters which might have been introduced into a general statement of the case from the electrical point of view. But if sufficient has been said to lead the textile reader to search for further information the object of these notes is accomplished. There is great good to be secured by the general use of electricity for lighting and power in every phase of textile manufacture and process. Electrical engineers have made electro-textile problems their special study. No hard-and-fast rules can be laid down for the guidance of all and every mill-owner, practice is essentially a matter of detail, and each contemplated electrical development, whether of mill conversion or from the ground upwards of a new factory, requires expert and full consideration before the start is made. Electrical engineers having experience in textile matters realise this. The mill-owner has only to approach the electrical manufacturer to learn to what extent and how the introduction of electricity will in his particular case work profitable reforms. And he must do it now lest he be left behind in the competitive race.

ELECTRICITY IN TEXTILE MILLS.

P. C. POPE.

The employment of electricity in textile mills is making very rapid headway in Lancashire and Yorkshire, and, at the present time, much interest is being taken in the discussion, now going on in the columns of the *Manchester Guardian*, on the relative advantages of steam and electrical driving. The advocates of steam power and steam engine makers really have nothing to fear from the progress of electricity. Their machines will continue to be called for, but the power that they develop will be economically transmitted and used by means of electrical generators, cables and motors, instead of being uneconomically used in older and less efficient and less elastic systems of rope, belt, and gear drives. The steam engine and boiler builders have everything to gain, as any saving in the cost of production of textile fabrics will tend to develop the demand for them, and will therefore increase the employment of the prime movers necessary for their manufacture. Steam—in this country at any rate—is the only prime mover that need be seriously considered, and, in the textile trade, where the hours of working are uniform and the load constant, it will, almost without exception, pay the mill manager to put down his own plant and produce his own electrical energy.

It may be of interest to give the cost of producing electrical energy in a typical modern textile mill containing some 1300h.p. in motors, energy being supplied by two turbo-alternators of 500kw. capacity each. The mean average load is found to be 880kw. Coal costs 8s. 6d. per ton delivered, and the consumption of each turbine is 18lb. of steam per kw.-hour. The mill works for 2805 hours per year, and 300 tons of coal are yearly used for banking fires. The works costs are as follows:

880kw. × 2805 hours = 2,468,400 units per year.

2,468,400 units @ 18lb. of steam per unit and 2.7lb. of coal per unit = 2976 tons of coal per year, add 300 tons for banking.

3276 tons @ 8s. 6d. ...	£1,392	6	0
Wages	233	0	0
Oil, waste, and engine room stores	102	0	0
Accident insurance, say ...	240	0	0
Repairs, say	120	0	0
	£2,087	6	0

This equals about .203d. per unit.

If 10 per cent. is charged on the capital expenditure of the plant for interest and depreciation, the cost per unit becomes .32d. or less than one farthing per brake horse power per hour. It is certain that no corporation or public supply could afford to sell energy at so low a price as this.

A textile mill only works during the usual hours in the daytime, and during night-time, week-ends, and holidays its plant is standing still. But the corporation or public supply must keep its plant at work throughout every hour in the year to meet the demand that might be made upon it at any moment. Unless, therefore, the diversity factor of the system is a very good one, so that certain trades are at work while others have shut down, it follows that the charges for energy from this public supply station must be burdened with the excessive capital expenditure rendered necessary by the possibility of the call upon its plant which it legally must be in a position to meet at any time.

Moreover, the mill that generates its own energy has a self-contained plant. It makes and uses its electricity on the spot, as and when required, and its cost of distribution is negligible. But the public supply often has to transmit its energy through miles of costly mains, and, as such energy can only be transmitted at high pressure (often 10,000 volts), at the end of the transmission line transforming stations must be provided wherein to reduce the pressure of transmission to a usable and convenient

voltage. These transforming stations are not only costly to build and equip, but they contain apparatus—static transformers, motor-generators, rotaries, &c.—which are continuously wasting energy whether they are supplying energy to customers or not. Energy is also being continuously wasted in the transmission lines themselves. This loss in transmission and transformation nearly always amounts to at least 25 per cent., and frequently to 30 per cent., 35 per cent., and more.

The public supply of energy may be likened to a railway that must run so many trains a day whether there are passengers to patronise them or not. The trains are full when people go to work and when they return at night, and these unhappy travellers have to pay an extra price for their tickets because, during the middle of the day, the squire's wife wishes to go to town to buy a new hat.

The textile mill that produces its own energy with its own plant is like the man who cycles from his house to his factory, expending in so doing only the energy called for by the operation, together with the amount that his machine depreciates during the journey.

In the above case of a typical modern mill, wherein the average mean load is 880kw., two turbines of 500kw. capacity each are mentioned.

Each turbine can give out its 500kw. continuously with a minimum steam consumption, and, under normal conditions, they share the load between them.

Each, however, is capable of withstanding, whenever required, an overload of one hundred per cent. for ten hours with a slightly increased steam consumption.

Should therefore either turbine need repair the other can carry on the work of the mill by itself. This renders the mill immune against loss through stoppage and is a piece of sound engineering, initiated in this country by Siemens Brothers' Dynamo Works, Ltd., who are equipping four textile mills in this manner.

These mills contain some 320,000 spindles and are being provided with some 4400h.p. in motors. The generating plant, in each case, consists of two turbo-alternators, each capable of withstanding an overload of 100 per cent. for ten hours. The extra cost of two such turbines over one capable of driving the mill is surprisingly small, and is a very moderate premium to pay for insurance against possible loss caused by shutdown.

That the electrical driving of textile machinery is economical and efficient is becoming more and more apparent. In first cost there is little to choose between steam and electrical driving. In some cases steam will show a small saving, but, given a modern mill, an experienced architect, and sound engineering, such saving will seldom be much. When the saving in buildings, foundations, rope-race, and mill-wrighting is taken into consideration the first cost of an electrical drive will usually be about the same as that of a steam drive.

In convenience, adaptability, and elasticity, electricity wins all along the line, and is certainly equally as reliable when properly and substantially designed. Electrical driving undoubtedly increases output, not by increasing speed, but by making it uniform. The well-known steadiness of electrical driving—when turbo-alternators and alternating-current motors are employed—causes fewer ends to be broken, and this fact allows of the machinery being run at the maximum speed that the fabric will stand.

The speed of an alternating-current motor depends—for all intents and purposes—on the periodicity of the current supplied to it, and the periodicity can only vary with the speed of the prime mover. The best reciprocating engine made will only receive some five to six hundred impulses per minute, while the turbine, with its series of expansions, the multiplicity of its blades, the great weight and perfect balance of its moving parts, and its practically continuous flow of steam, will receive many hundreds and thousands of impulses per minute.

There can be no comparison between the steadiness of the two drives. This regularity of drive not only increases the output but also improves the quality of the yarn.

Many people still talk of electricity as being "in its infancy." Surely this is rubbish. We need only look at the part that electricity plays in everyone's daily life in lighting, cooking, heating, traction, power, telegraphs, telephones, and the like, to see that it has attained to vigorous manhood. Let us "free our minds from cant" and recognise that electricity in its manifold uses is one of the most tremendous and beneficial forces of nature that mankind has at its service to-day.

THE ELECTRIC DRIVING OF COTTON AND WOOLLEN MILLS.

FRANK NASMITH (Editor of "The Textile Recorder.")

DURING the past four years a wave of prosperity has swept over the two great industrial counties of Lancashire and Yorkshire affecting both the cotton and woollen industries. In Lancashire an enormous number of new mills have been erected, and during 1906 alone no less than 8,000,000 new spindles and 77,000 new looms were installed. Although the woollen industry has no figures of a like nature to show, there is not the slightest doubt that extension has been taking place in many directions. It is a well-known fact that America and Germany are ahead of us as regards the installation of the electric drive in textile mills, and this fact may have caused engineers in this country to consider the driving problem, but the author's opinion is that it has been the boom in building which has completely centred the attention of the driving engineers to the enormous field which Lancashire and Yorkshire present for their products. It follows almost as a matter of course that the mills situated in India and Canada have not been forgotten. A few years ago the steam engineer held undisputed sway in Lancashire, and we might say throughout the whole of the textile industry, as regards the driving of textile mills. Certainly we find isolated cases in which other methods of driving have been employed for years, but the

FIG. 1. THE CURZON MILL. TYPE OF LANCASHIRE STEAM-DRIVEN MILL.

number of such is comparatively small. At the present time, however, the steam engineer has three competitors, and although their influence has not been felt to a considerable extent up to the present time, there is not the least doubt in the writer's mind that great changes will be seen during the next few years.

First and foremost there is the electrical engineer, who will probably prove the biggest adversary to the steam engineer; secondly the gas engineer with his producer plant capable of reducing the cost per h.p. hour to an extremely low figure; and lastly the engineer who employs the oil engine as the unit of power. The last two do not concern us in the present article. Suffice it for us to repeat that the eyes of the engineering world in all directions have been opened to the enormous field presented by the textile industries throughout the world and to add that where there was practically a monopoly in the past there will be strenuous competition in the future.

It has been proved to the writer over and over again that with the exception of a comparatively small number of electrical engineers, the requirements of the textile industries as regards driving are an unknown quantity. Certainly there have been go-ahead firms who, having studied the subject closely, have spent considerable sums in experimenting, but their number is comparatively small. It should be understood at once that the driving of a cotton-spinning mill, for instance, presents conditions which are quite apart from any other class of drive. Not only so, but each mill will have to be approached separately, and no general rule can possibly be laid down as a guide to engineers. Although the knowledge of the subject is increasing, electrical engineers generally are only just arriving at a position to compete with the steam engineers who for years have been studying the problem, and who have devised engines and gearing which have reached the perfection of steam power and mechanical transmission as applied for textile purposes. The writer has great hopes for the use of electricity as the driving medium for textile mills, but at the same time urges electrical engineers to leave no stone unturned in obtaining knowledge, and to appreciate the fact that only by the most strenuous efforts will a large proportion of the installations be obtained. It is the intention in the following article, before dealing directly with electrical driving, to briefly outline the

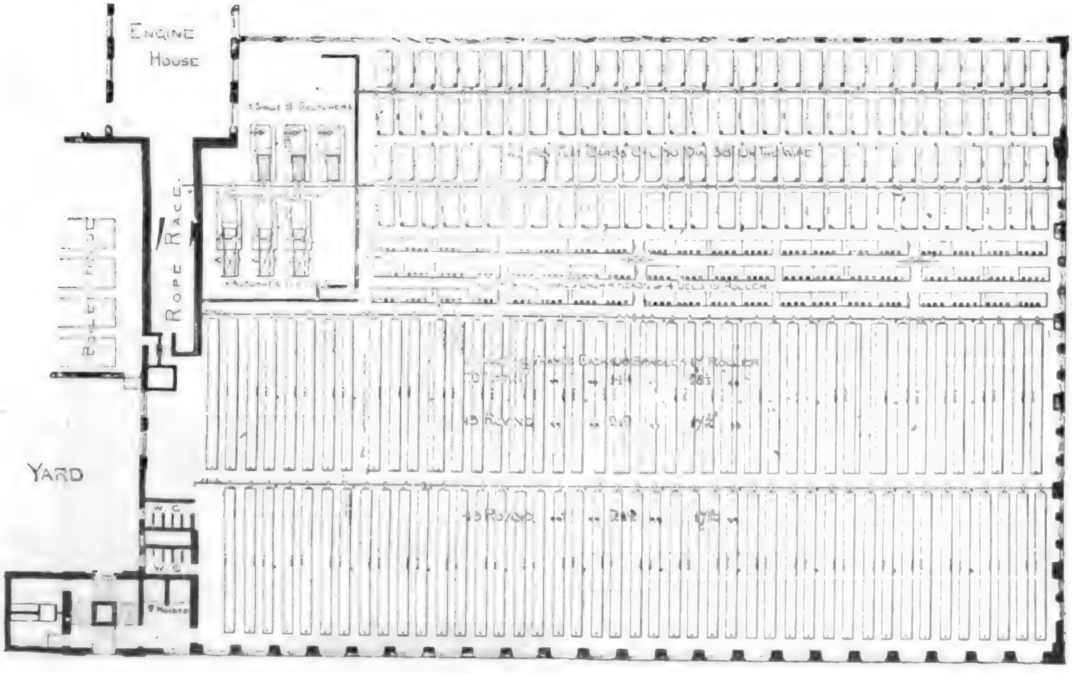


FIG. 2. PLAN OF CARD ROOM.

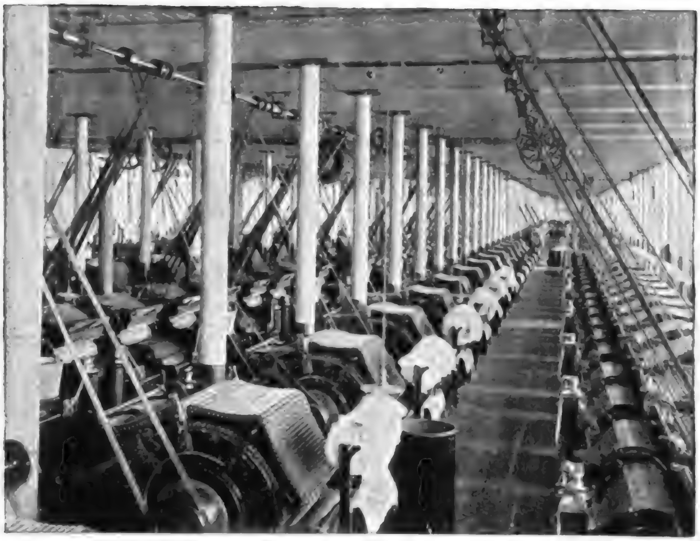


FIG. 3. CARD ROOM, BUTLER MILL.

engine house and rope race is clearly shown. The rope race extends from the bottom to the top of the mill. The employment of ropes for the purpose of driving modern mills is almost universally adopted. The advantages gained are many, but probably the one which affects the object of this article most is the extreme steadiness obtained. Combined with a moderate-running steam engine, as now designed, great and constant steadiness with comparatively little loss of power in transmission is obtained; the loss has been estimated as 5 per cent. Steadiness is certainly proved beyond question by the manner in which fine counts can be spun in Lancashire, although, of course, credit must be given to the operative spinner of that county for his inherited knowledge. The grouping of the various machines in the card room as shown in Fig. 2 is typical of cotton mills in Lancacashire, varying only slightly in certain cases.

A typical American mill is the Butler mill, equipped by the above-mentioned firm, illustrations of the interior of which are

construction, arrangement, machinery, and drive of a cotton mill as now existent in Lancashire.

There can be no gainsaying the fact that the modern mill is most peculiarly and admirably adapted for its purpose. A century of experience has been brought to bear upon the subject, and in every direction, either as regards the construction of the mill, its millwrighting equipment, its productive machinery, or its driving unit, an infinitude of knowledge and consequently a great perfection in detail is displayed. The Curzon mill, of which an illustration is given in Fig. 1 (equipped with spinning machinery by Messrs. John Hetherington & Son, Ltd., Manchester) is a typical example of a modern Lancashire cotton mill. It will be seen that the mill is tall, the rooms also are exceptionally lofty. The engine room is shown to the right of the picture and at one end of the mill. This is a typical arrangement. In Fig. 2, which is a plan view of a card room, the arrangement of the

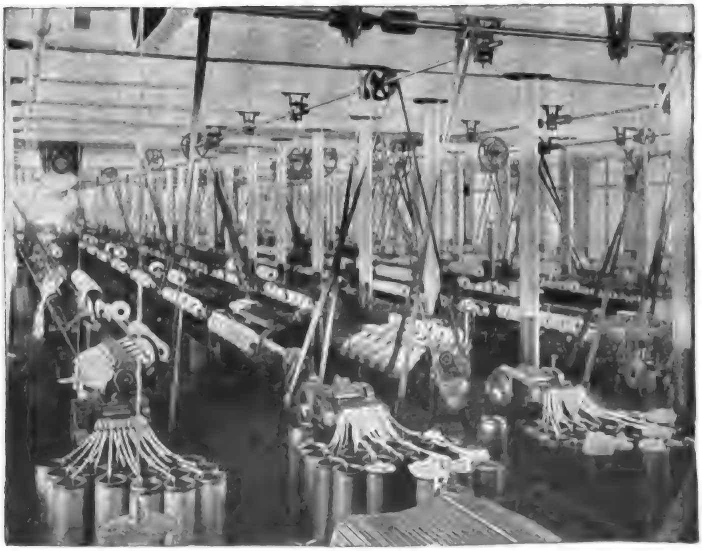


FIG 4. CARD ROOM, BUTLER MILL.

FIG. 5. MULE ROOM, BUTLER MILL.

Intermediate frame...1 i.h.p. to 60 spindles

Roving frame ... 1 i.h.p. to 70 spindles

Self-acting Mule ... 1 i.h.p. to 110 spindles for twist

Self-acting mule ... 1 i.h.p. to 120 spindles, for weft

Winding frame ... 1 i.h.p. for 120 to 160 spindles

It may be reckoned that by adding 20 per cent. to the total h.p. for friction losses, &c., from the engine to the driving shaft of the machine, the total h.p. of the engine requisite for driving the whole mill is obtained.

given in Figs. 3, 4, 5, and 6. The following figures may be taken as an approximate estimate of the cost of a steam plant of 1000 i.h.p. employing a rope drive:—

Two 500 i.h.p. engines and boilers, economisers, superheaters, and all accessories up to flywheel shaft	£10,000
Ropes, rope pulleys, and all shafting with necessary pulleys	£5,000
Total	£15,000

The following figures show the powers required to drive plain looms employed weaving calicoes and the necessary preparatory machinery. Winding frames have been ignored, as the power required for them is stated in the table given above.

Beaming machine ...	.30 i.h.p.
Size-mixing apparatus	2½ ,,
Slasher sizing machine	1½ ,,
Plain loom	.16 ,,
Plaiting machine ...	½ ,,
Cloth press	1½ ,,

The cost per i.h.p. can be placed as low as one fifth of a penny for a mill spinning medium counts. This is a fair average.

The following table shows the approximate power required to drive each machine in a mill equipped as that shown in Fig. 2.

Porcupine opener ... 5h.p.

Single beater scutcher 4h.p.

Revolving flat card .75h.p.

Drawing frame ... 1 i.h.p. for every 14 deliveries

Slubbing frame ... 1 i.h.p. to 50 spindles

FIG. 6. PREPARATION FRAMES, BUTLER MILL.

Of course, all the mills still paying dividends in Lancashire are not built on modern lines, and there are still many in existence employing the old-fashioned beam engine and a great amount of bevel gearing, similar to that shown in Fig. 7, for transmitting power. In such a mill the loss in transmission of power is considerable, and it is only with full regard to the economy of each and every department that such mills can hold their own. What will happen when trade begins to slacken the writer cannot foretell, but it certainly stands to reason that the many new mills fitted with all the latest labour and power saving devices will stand an infinitely better chance of surviving. Before leaving the subject of the mill as it exists, it will be as well to point out that a cotton or woollen mill under ordinary circumstances runs the whole of its machinery from 6 till 5.30 each day, or approximately sixty hours per week, and, therefore, a constant full power supply is requisite. Departmental work as regards the majority of mills does not exist.

We have heard quite recently the phrase that the electrical driving of textile mills is only in its infancy. Although we recognise the fact that the number of mills which are employing electricity for the purposes of driving is small compared with the total number of mills in existence, this phrase to our mind considerably belittles the work which has been and is at the present time being accomplished. Taking into account the fact that it is only during the last three or four years that electricity has really been seriously considered as a motive power for textile mills in this country, the number of mills which have been equipped with it mark considerable progress. As hinted in an earlier portion of this article, when electrical engineers come to fully understand the requirements of the industry, it is our belief that widespread changes will be seen. The chief advantages which textile spinners

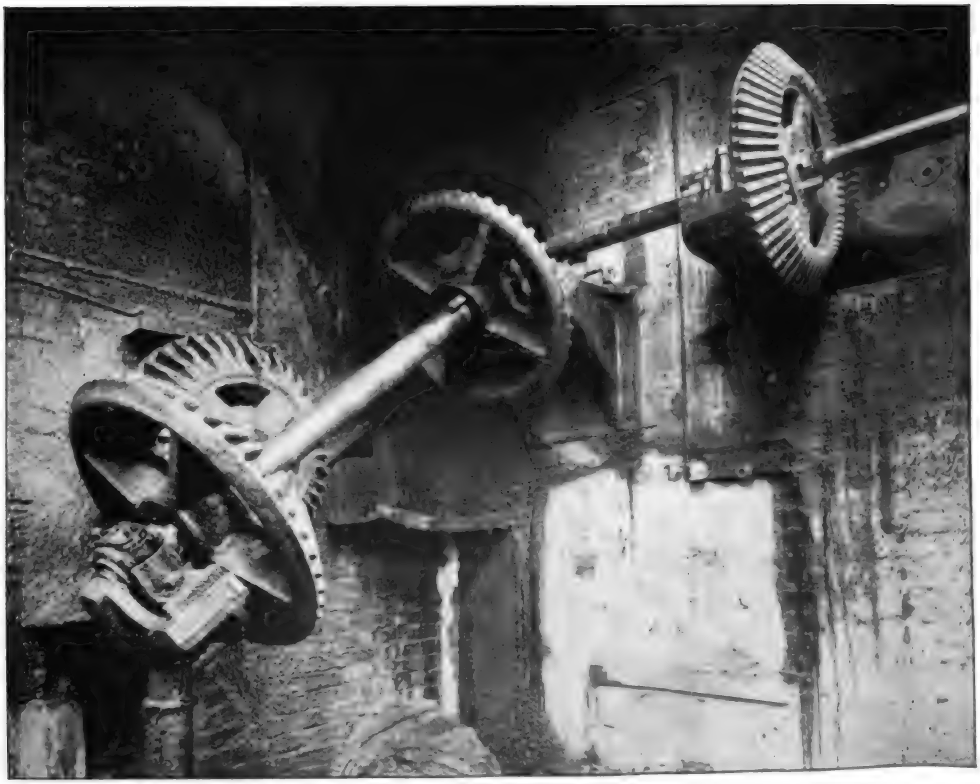


Fig 7 An Old Style Transmission.

and manufacturers have to consider may be summed up as follows.

The prime mover and machinery may be placed in any relative position.

Each machine can be driven independently without reference to others, and where grouping is necessary greater simplicity is possible with less cost in regard to shafting.

Greater steadiness of driving and consequent greater output of each machine.

Greater immunity from breakdown.

Less cost in running on light loads.

Where current is obtained from central power station great reduction in capital outlay.

Continual check on the power consumed in the total, and in each department, is possible by use of recording instruments.

Greater simplicity and convenience since power and light can be obtained off the same circuit.

It cannot be too largely impressed upon readers that there is the necessity for studying each case individually. In certain cases it will pay to install a complete generating plant and distribute motors throughout the mill which can drive the various line shafts; in other cases the purchase of power from some central station is more advantageous. It will, however, be found that in the majority of mills it will pay to generate the electricity at the mill itself and drive the machinery in groups driven from high-speed shafts coupled direct to motors. The following description of various methods of employing the electric drive has been carefully selected with a view of bringing together as far as possible every known arrangement. It should be understood that the drives illustrated are in no sense of the word *exhibition* drives, but are actual drives at present working in the cotton and woollen mills of this and other countries.

The first mill which will be described is one which has been in existence for fifty years, and which up to twelve months ago was employing an old-fashioned beam engine

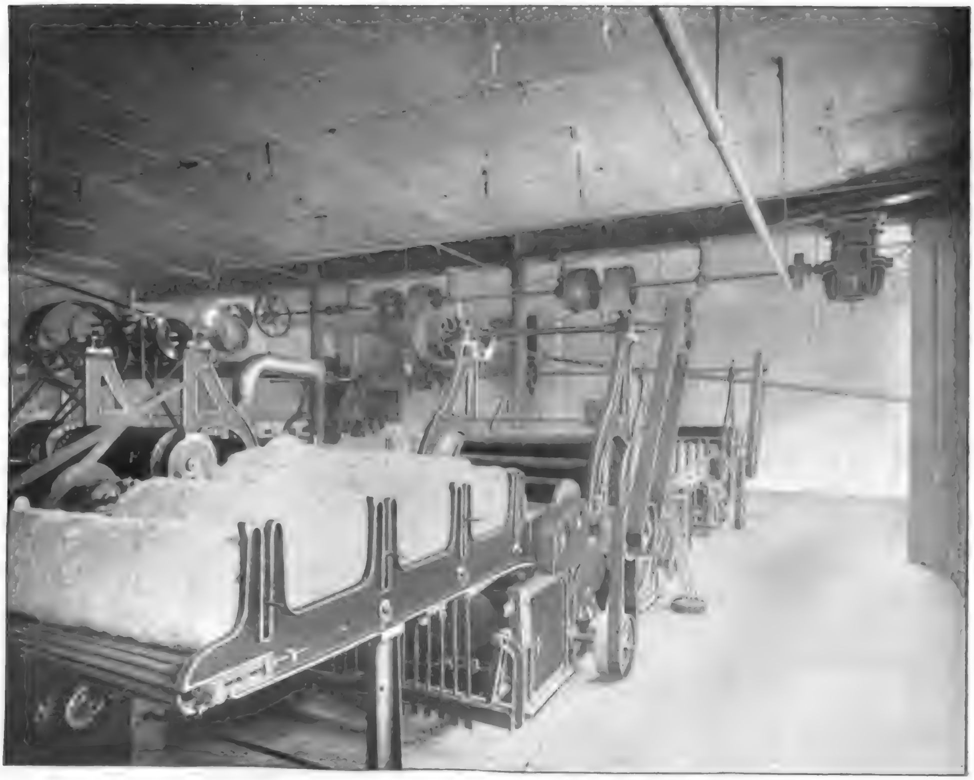


Fig. 8. Electric Drive in Blowing Room.

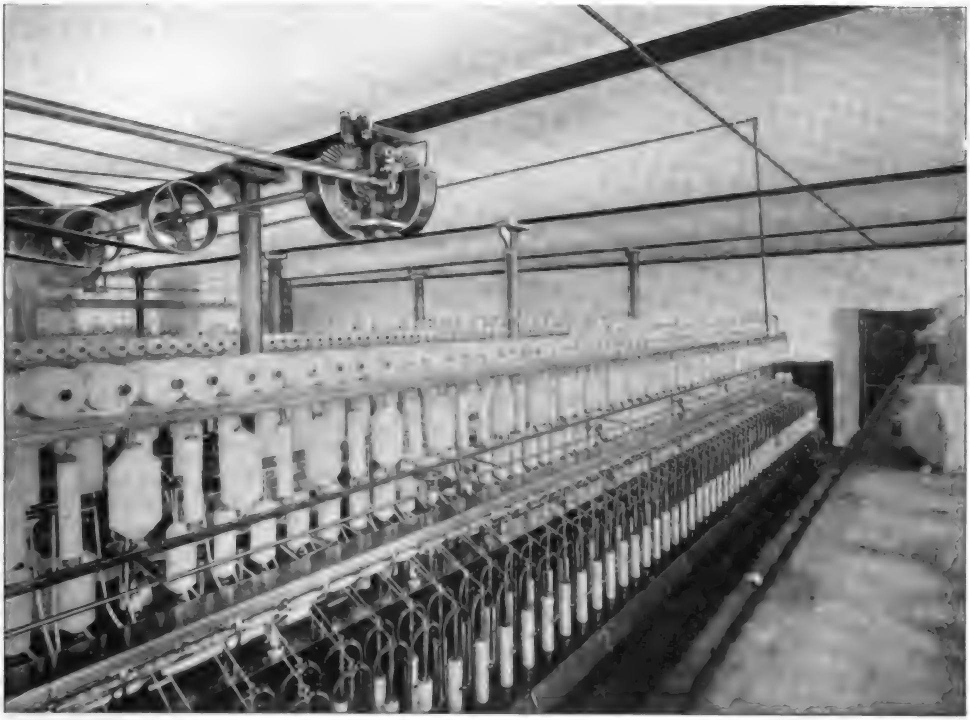


Fig. 9. Preparation Room before Conversion.

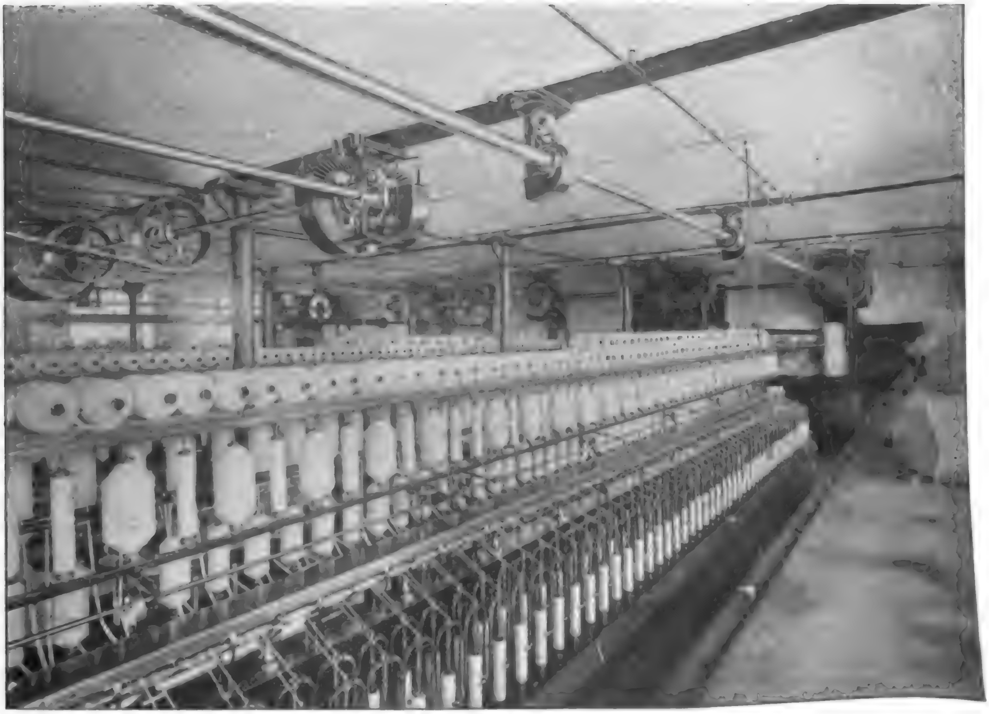


Fig. 10. Preparation Room after Conversion

for driving purposes. The mill referred to is that of Messrs. Ashworth, Hadwen, & Co., Ltd., Fairfield, and the conversion from the method of driving by steam power to electricity was carried out by Messrs. Drake & Gorham, Ltd., of London.

In the first place it must be understood that the whole work of conversion was accomplished without the mill being stopped during working hours, and in the words of one of the directors "not an ounce of yarn or a yard of cloth was lost through the operation." When we consider the fact that the new boilers, for instance, are connected to the old flues, economisers, and chimney shaft, and that they now occupy the site of the original boilers, the difficulty of the task presented to the engineers will be apparent. The electricity, as will be gathered, is generated at the mill, and the new plant consists of the latest pattern water tube boilers, each fitted with integral superheaters, automatic travelling grate stokers, the fuel being fed into the hoppers of the latter automatically by means of a travelling bucket elevator and an overhead bunker. Steam is delivered at a working pressure of 180lb. per square inch to the new electric generating plant. The engine employed consists of the very latest pattern of steam turbine, which covers 960 sq. ft. of floor space, weighs 20 tons, yields over 1000h.p., and runs at 1500r.p.m. The electric generator and switchboard are contained within the engine room. The costs of power and light at this mill work out as follows. The figures have been supplied by Messrs. Drake & Gorham.

Coal, oil, stores and labour ...	0.132	pence per unit
Interest on capital, depreciation, repairs, and maintenance	0.131	,, ,, ,,
Total ...	0.263	,, ,, ,,

These are certainly astonishing figures and quite equal to, if not better than,

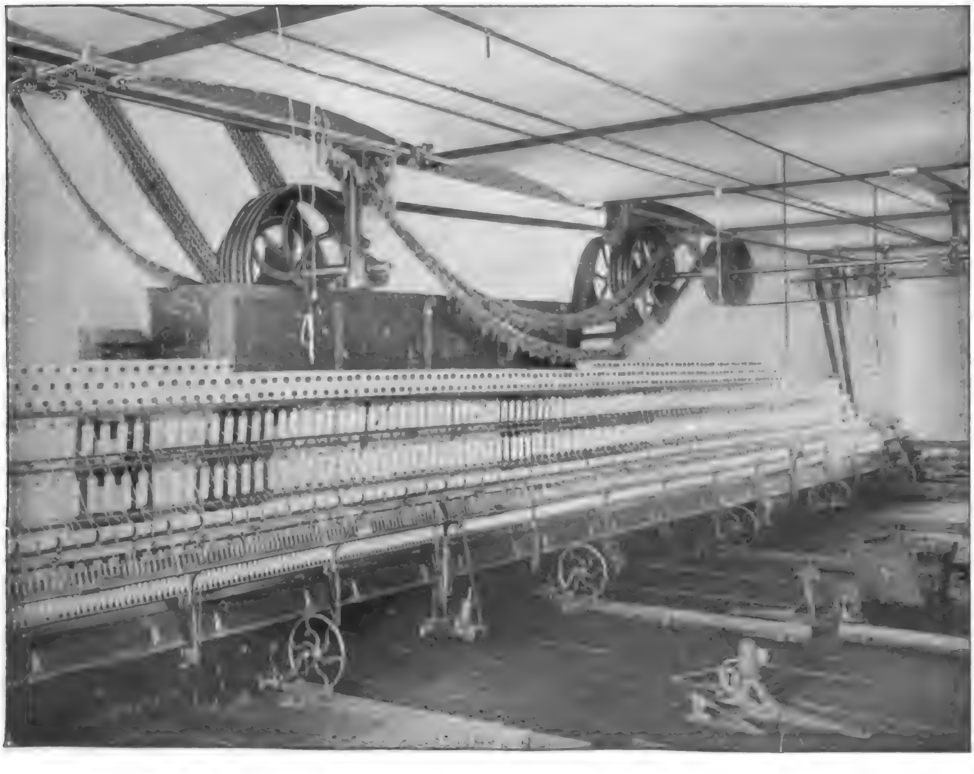


Fig. 11. Mule Room before Conversion

others that have ever been obtained in connection with the driving of textile mills by electricity.

The arrangement employed in the blowing room of this mill is clearly shown in the illustration, Fig. 8. A motor is bolted to the ceiling, and is direct-coupled to a high-speed light line shaft, running at nearly 600r.p.m. It is claimed that as each machine is being driven direct from this high-speed line shaft the pulleys and belting are lighter, and the loss in transmission inherent with any mechanical system is materially reduced.

The stoppage of an entire mill through the occurrence of a hot bearing on a line shaft is a matter which cannot be overlooked. By the employment of motors which can be controlled in the department they are intended to drive, this difficulty is easily obviated. Figs. 9 and 10 show views of the preparation machinery before and after the conversion respectively. It will be noticed from Fig. 10 that several pairs of bevel wheels have been dispensed with, thus materially reducing the friction losses. In Fig. 11 we see the old arrangement for driving one of the mule rooms. The power was transmitted from the floor above by means of ropes to a counter shaft, and from thence to the line shaft, the power having been previously carried to the upper floor by means of a vertical shaft.

An extremely neat arrangement for one of the mule rooms is shown in Fig. 12. It will be seen that the motor is set in the wall, and that it has coupled to it a rope pulley. Not only does this pulley drive the mules in the room in which it is situated, but it also drives the mules in the rooms immediately above and below it.

The change made in the sizing house has been remarkable, and in Fig. 13 the loftiness and generally airy appearance of the room will be noticed. The motor is slung under one of the roof principals, out of the way, and by means of an auxiliary engine-driven generator, it can be run during meal hours, and can be stopped from the engine-room

Fig. 12. Mule Room after Conversion.

FIG. 13. SIZING HOUSE AFTER CONVERSION.

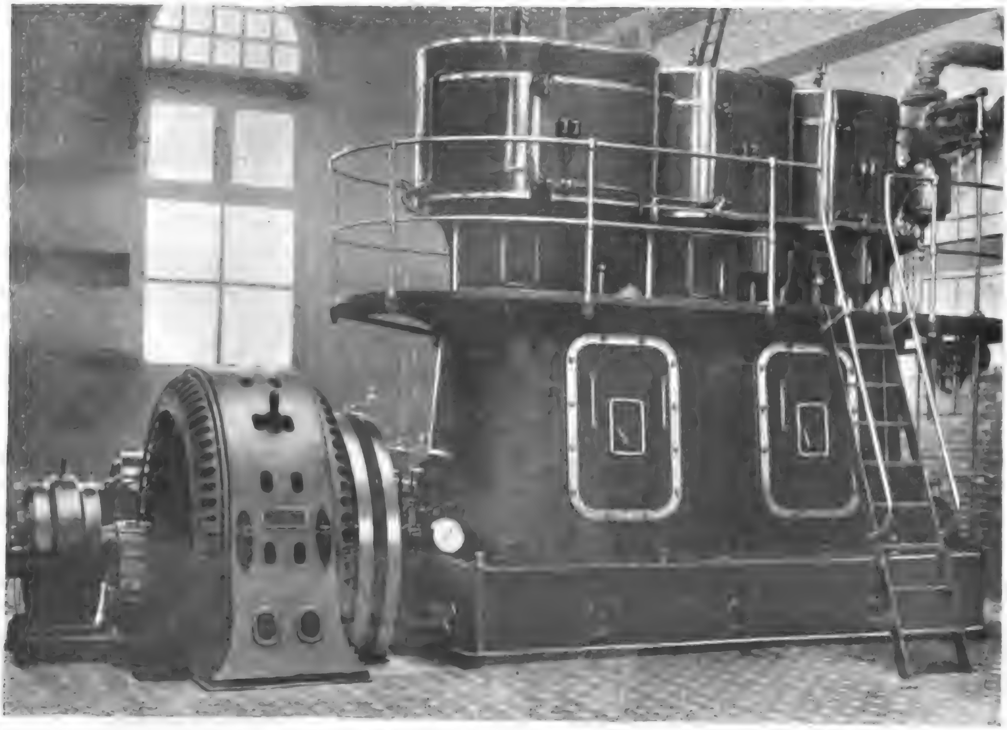


FIG. 14 ENGINE AND THREE-PHASE ALTERNATOR DRIVING WEAVING SHED.

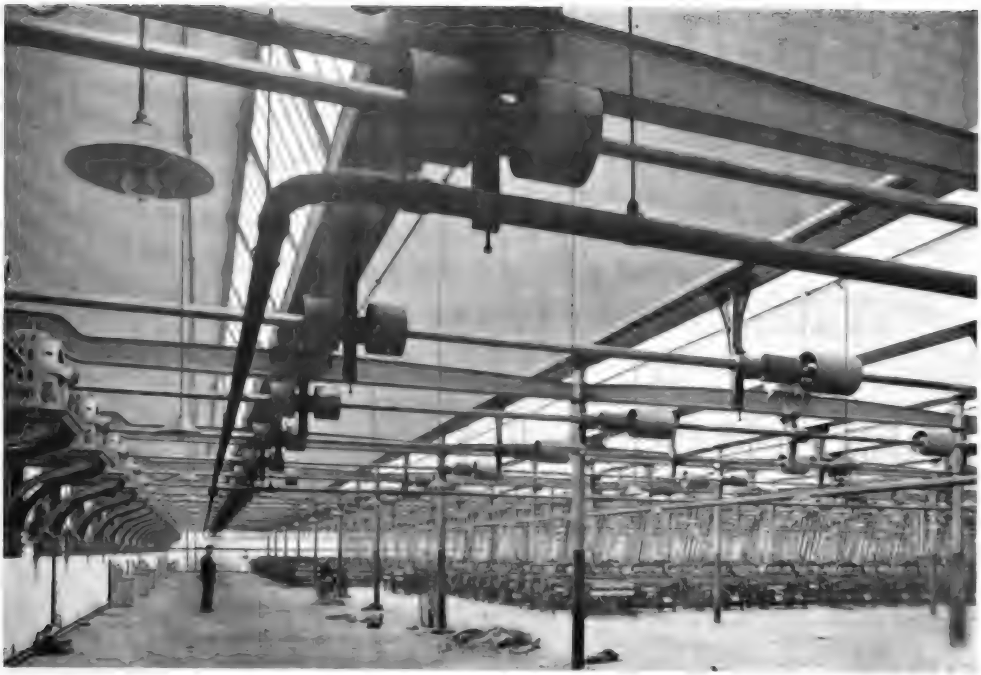


FIG. 15. WEAVING SHED DRIVEN BY MOTORS.

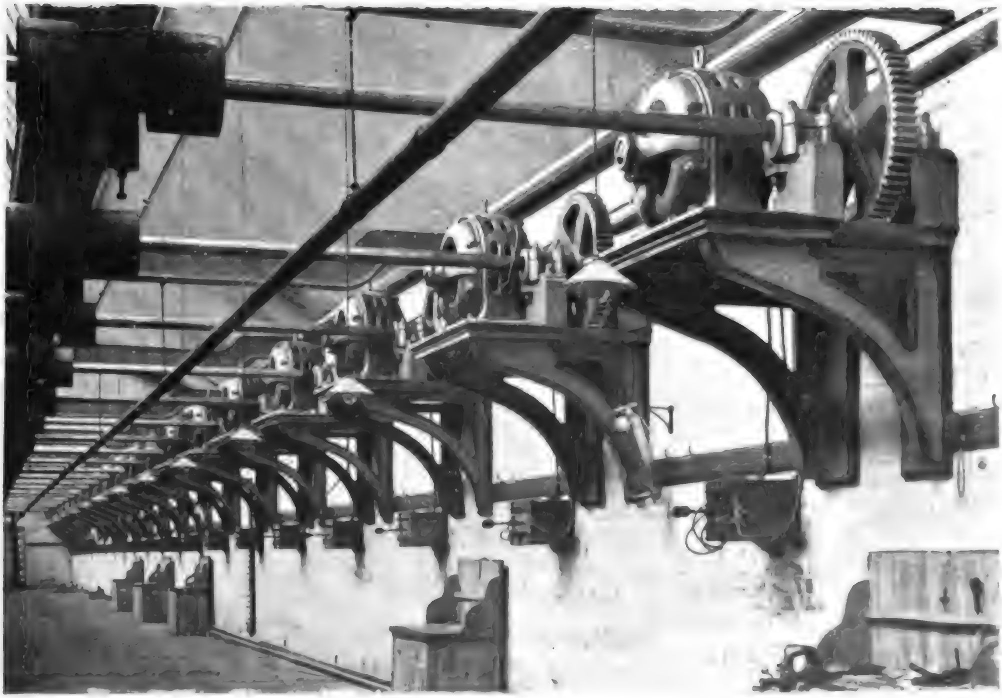


FIG 16. MOTORS DRIVING WEAVING SHED.

together with the other motors in the mill.

There can be no doubt that the method employed in treating this old type of mill has been the correct one. The machines have been speeded up throughout, and after a little experience of the new running, the operatives have been able to tend them quite as well as hitherto. From 4 to 7 per cent. increase in speed has been obtained.

Having just described an old cotton-spinning and weaving mill in which a conversion to electric driving has been made, as a contrast we will give some particulars of a new weaving shed belonging to the Heasandford Manufacturing Company, near Burnley, which has been equipped with electrical plant by Messrs. Mather & Platt, Ltd., Salford Iron Works, Manchester. The generating plant, Fig. 14, consists of a Belliss engine, direct-coupled to a three-phase alternator, giving a normal output of 550k.v.a. at a pressure of 440 volts, and 50 cycles per second when running at 330r.p.m., and a 200k.v.a. set of similar type, both being provided with exciters mounted on the same bed plates as the alternators, and direct-coupled in each case. The generating plant is capable of giving the usual 25 per cent. overload. In Figs. 15 and 16 are given two views of the weaving shed, in which, at the time the photographs were taken, 1600 looms, made by Messrs. Pemberton & Co, of Burnley, were located. It will be seen that the motors, of which there are 23 in the weaving shed, are supported by wall brackets, and drive, through raw-hide pinions and cut steel gears, the line-shafts which extend across the shed. Each of the line-shafts drives a double row of looms, with the exception of the two end shafts. The motors for driving the former are 25b.h.p. each, and for the latter, in which case only a single row of looms is driven, 14b.h.p. In the winding and warping room and the sizing house, single motors are employed. All the motors are of the induction type, with squirrel cage windings. Each motor is provided with a starting switch on the wall immediately below it. This mill, which was specially designed to employ electric driving, was the first of its kind in this country, and naturally

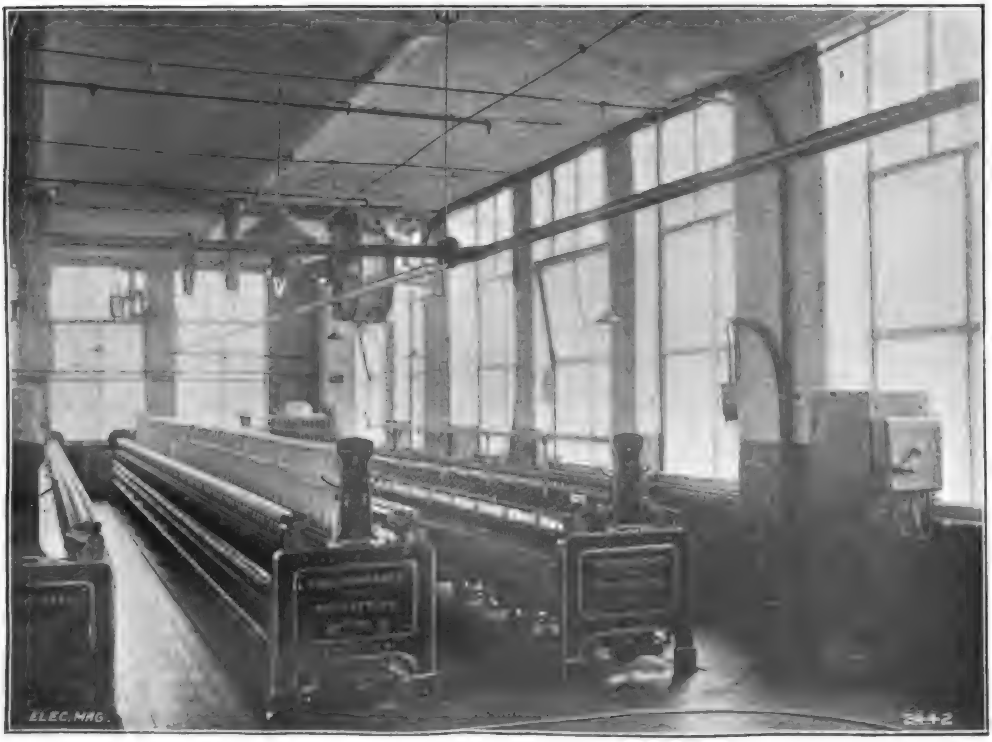


Fig. 17. 150b.h.p. Motor driving Ring Frames, Acme Mill.

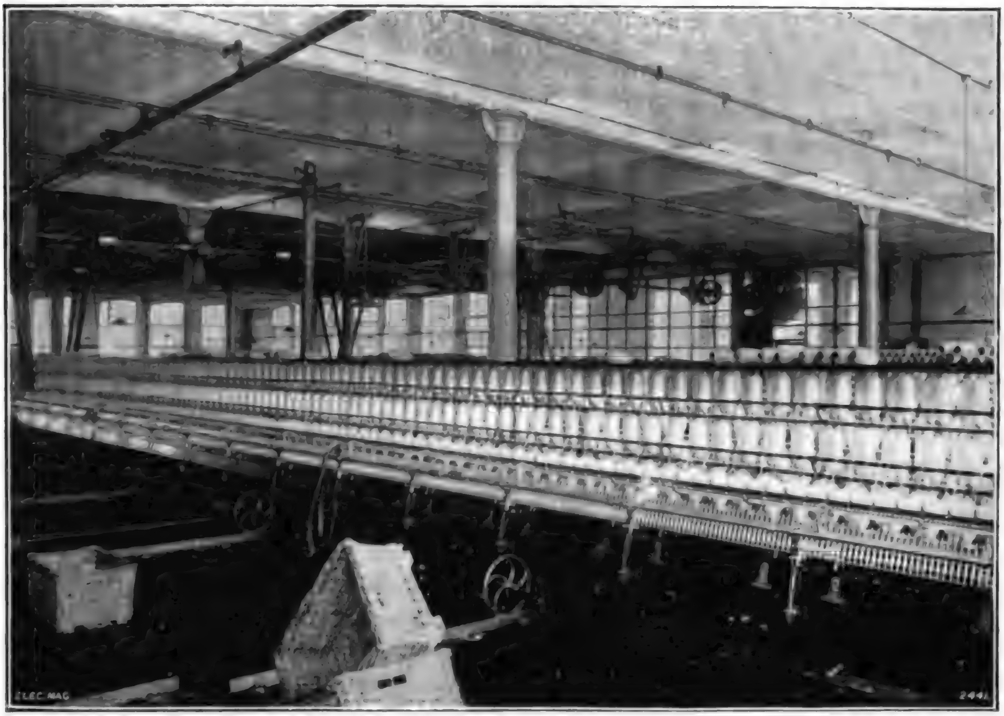


FIG. 18. 200B H.P. MOTOR DRIVING MULE ROOM, ACME MILL.

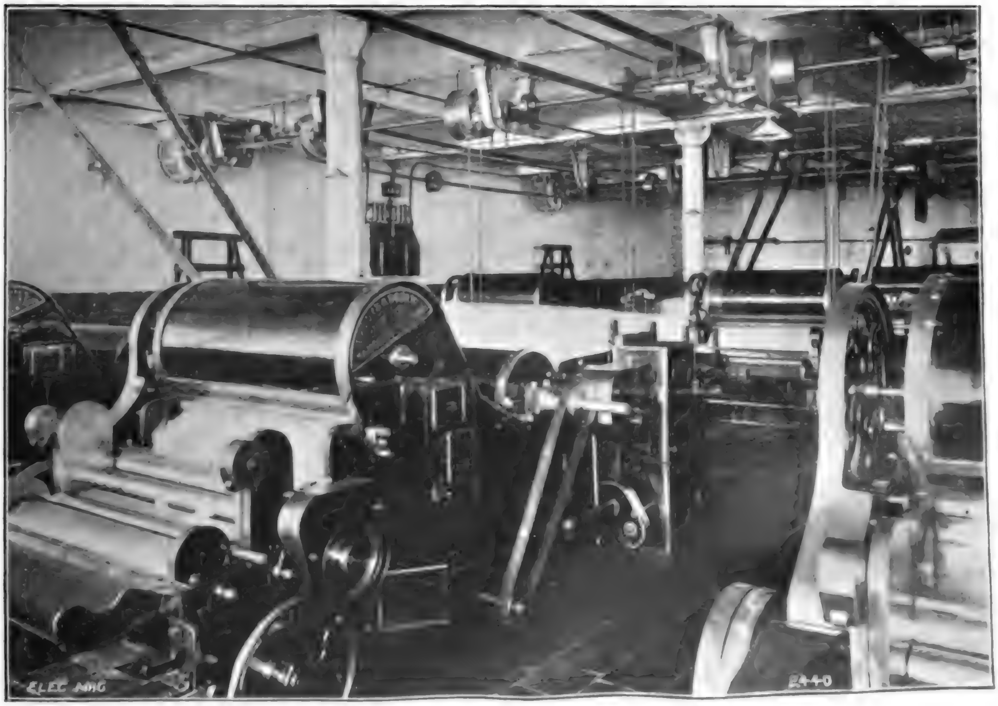


FIG. 19. 40B.H.P. MOTOR DRIVING BLOWING ROOM, ACME MILL.

was looked upon in the first place as somewhat in the light of an experiment. We believe that excellent results have been obtained, and that the number of looms originally employed has been increased.

Another example of the manner in which the electrical drive can be employed is exemplified by the Acme Mill at Pendlebury, "the mill without a chimney," as it is often called. The power in this case is obtained from the Lancashire Electric Power Company's generating station, which is situated at Radcliffe. The distance traversed by the current is about six miles. A number of illustrations of this mill are given, Figs. 17, 18, 19, and 20, but the writer has not been able to obtain any accurate data as to the amount of power consumed, efficiency, and increase in production. The electrical work is by the British Thomson Houston Co., Ltd.

The mill contains 41,000 mule and 34,000 ring spindles, together with the necessary preparation and winding machinery. The illustrations show that the group method of driving has been employed, the motors, which are in the majority of cases suspended from the ceiling, being directly coupled to the mill shafting by means of flexible couplings. Of course it will be understood that the current as received at the mill is not used direct. It is transmitted from the power station at Radcliffe at a pressure of 10,000 volts to the mill transformer chamber, where it is transformed to a pressure of 400 volts for use in the motors driving the various rooms.

The size of motor employed in the ring spinning room is one generating 150h.p., and as will be seen from Fig. 17 these motors are directly connected to the line shafts. Belts are dispensed with and in their stead single-rope drives employed to drive the separate machines. A similar arrangement is employed in the mule rooms, where a 200h.p. motor running at 580r.p.m. is employed. This arrangement is shown in Fig. 18.

FIG. 20. 12B.H.P. INDUCTION MOTOR IN THE BALE BREAKER AND MIXING ROOM, ACME MILL

In the foregoing descriptions some information has been given about installations in mills situated in this country, and before leaving the subject of complete mill installations it will be advisable to show what is being done in India, which colony has made almost phenomenal progress in cotton spinning and manufacturing. Situated in and about Bombay there are a great number of mills which are excellently managed, and the question of driving has not failed to escape the notice of both European and native mill owners. The author has been informed on good authority that every important office in India has on its files a very complete library on this subject. While this is carefully studied and discussed, the Indian manufacturer seems to have passed the stage of theoretical discussion and is now at the stage of practical experiment. Many have already decided in favour of the electric drive, and all that he now seeks to discover is which of the various systems presented is the most economical or otherwise the most advantageous.

The textile manufacturers in India have always shown a preference for English machinery, and several persistent efforts, made during the last five years, to introduce German boilers, American spindles, and Japanese looms, have met with no success whatever. In the question of electrification of mills the same desire for British machinery appears to be evident amongst the mill

Fig. 21. The Electric Power House of the Hastings Mill (India).

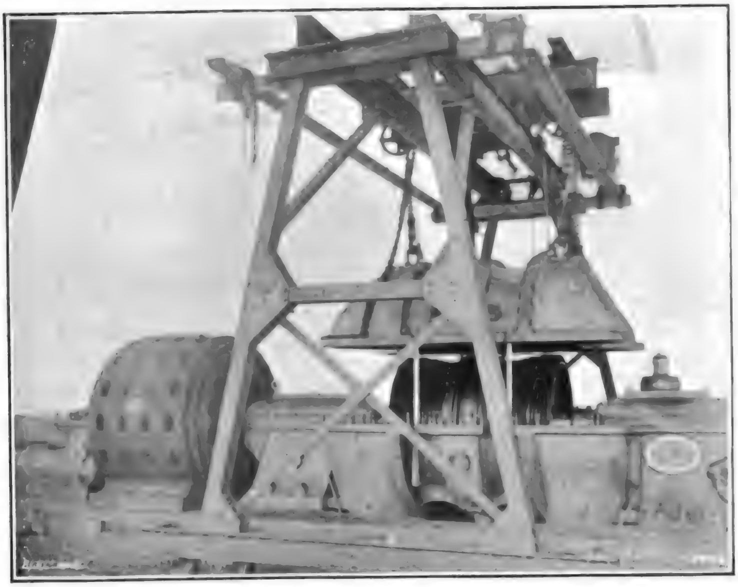


FIG 22. WESTINGHOUSE TURBO-GENERATOR SET. THE HASTINGS MILL.

owners. The British Westinghouse Electric and Manufacturing Company, of Manchester and London, have done a great deal of work in the Empire, and the following particulars of mill drives in India have been collected by them.

In the illustration we give herewith, Fig. 21, the generating station of the Hastings Mill, owned by Messrs. Birkmyre Bros., is shown. This mill is engaged in spinning jute, and has been equipped throughout with electrical plant by the above-named firm. The generating plant consists of a Westinghouse steam-turbine generating station with a couple of 1500kw. generators, Fig. 22, and one small 150kw. generator for the independent working of shops, pumps, cranes, &c. Power is transmitted to the factory by overhead cables, The old steam drive shafting has been made suitable for driving by motors. In the preparation department all the fibre softeners are worked in groups by 50h.p. motors, and other machinery such as breakers, finishers, drawing and roving frames, are driven from a shaft driven in turn by one 700h.p. motor, Fig. 23. The spinning department works with one 700h.p. and one 400h.p. motor. The looms and calenders employ two 700h.p. motors, and small motors of various capacities work the shops, pumps, cranes, &c.

A small cotton mill in Northern India has been equipped by the same firm to the order of Messrs. Bootee and Sons. The plant consists of a 300kw. Westinghouse turbo-alternator set, complete with surface condenser. Two 75h.p. motors and three 50h.p. motors will work the mills in all departments, except the ring spinning frames which are to be worked by two dozen small motors of 7½h.p. each. This mill should undoubtedly furnish interesting particulars of the cost, efficiency, and rate of production obtained by departmental driving.

A further plant, which is not as yet installed, has been designed to operate the cotton mill of Messrs. Finlay Muir at Bombay. Although there is a scheme on foot to erect a large hydro-electric power station, which promises to deliver about 45,000h.p. to the mills and other factories of the city, the Finlay mills have decided to generate their own power. Diesel oil engines are to be employed to drive two 300kw. Westinghouse generators. One 200h.p. motor will work the weaving department, with additional small motors for calenders and finishing machinery. Seven other powerful motors, ranging from 75h.p. to 175h.p., will drive the main departments of the mill. Having now dealt with various methods of employing the electric drive throughout a mill we will proceed to give some particulars of various drives in which the motors are coupled direct to a single machine, or at the most drive two machines. Messrs. Siemens Bros. Dynamo Works, Ltd., have adopted the following 3 standard driving arrangements for looms. It may be taken that heavy looms are more particularly referred to. In the first arrangement the motor is generally fixed to the floor as shown in Figs. 24 and 25. Three-phase motors are employed, and the loom is driven by means of a belt kept at the proper tension by a spring suspension device attached to the motor as shown in Fig. 26. It is stated that

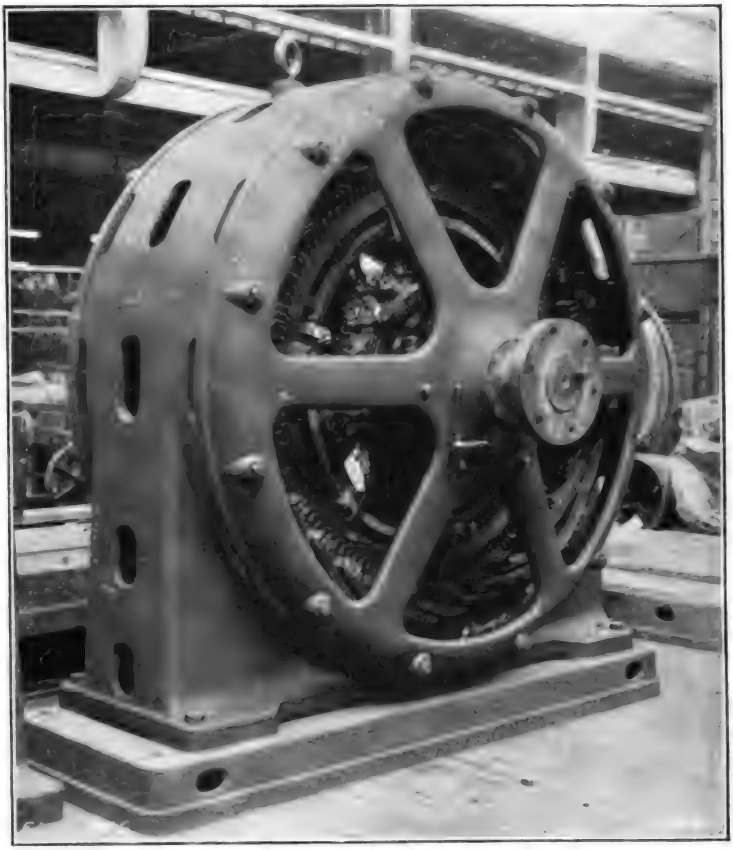


FIG. 23. 700H.P. MOTOR. THE HASTINGS MILL.

this kind of drive is inexpensive and is recommended as being suitable for driving simple and comparatively cheap looms. In the second arrangement adopted, the motor and gearing are mounted in an upright iron frame as shown in Figs. 27 and 28. On the top of this frame there is a bearing to support and extend the shaft A of the loom. In order to prevent excessive strains in the gearing and motor, a friction coupling is inserted between the pinion and the large gear wheel. The arrangement is as follows: The brake drum B is keyed to the shaft of the loom, and the large gear wheel C is connected to B by means of a brake band. The tension of the latter can be adjusted by a spring F, and nut G. The tension of the spring F is so adjusted that only the torque required for driving the loom is transmitted. In case this predetermined torque is exceeded, the band brake begins to slip. As shown in the illustrations, the motor can be adjusted in the frame in order to enable pinions of various diameters to be used. In this way it is possible to obtain any gear ratio within limits. The third arrangement is identical with the second excepting that the friction coupling is replaced by a centrifugal device which puts in the clutch as soon as the motor has attained 85 per cent. to 90 per cent. of its synchronous speed. The motor, therefore, starts on no load and can thus be of considerably smaller size than if it had to start up the loom from rest. The putting in of the clutch is stated to be definite and free from shock.

In the following table some particulars of the seven sizes of motors Messrs. Siemens use for driving looms are given. Each size is made in two modifications, one having a starting torque of twice the normal torque, the other capable of exerting three times normal torque.

MOTORS WITH SPRING SUSPENSION FOR DRIVING LOOMS.

Output h.p.	Motors with starting torque equal to twice normal running torque.		Motors with starting torque equal to three times normal running torque.	
	Revs. per minute (50 ∽)	Nett Weight lbs.	Revs. per minute (50 ∽)	Nett Weight lbs.
$\frac{1}{4}$	900	62	910	62
$\frac{1}{3}$	910	71	930	71
$\frac{1}{2}$	920	78	940	78
$\frac{3}{4}$	930	93	945	93
1	940	110	950	110
$1\frac{1}{2}$	940	135	960	135
2	950	165	960	165

In an earlier portion of this article an account has been given of the application of motors to ring spinning frames, the motors being coupled up direct to the frame itself.

Fig. 24. Large Loom driven by Single Motor.

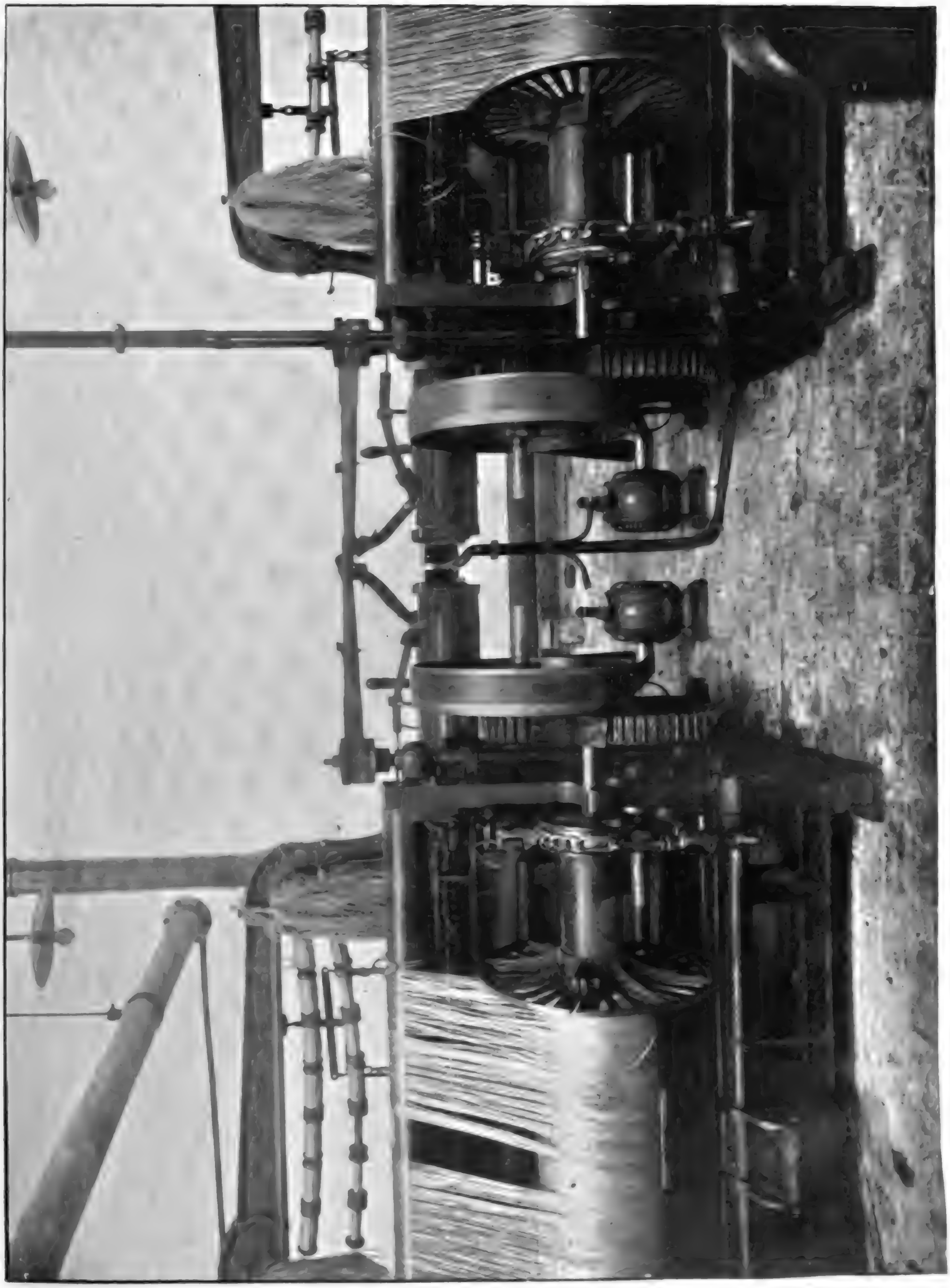


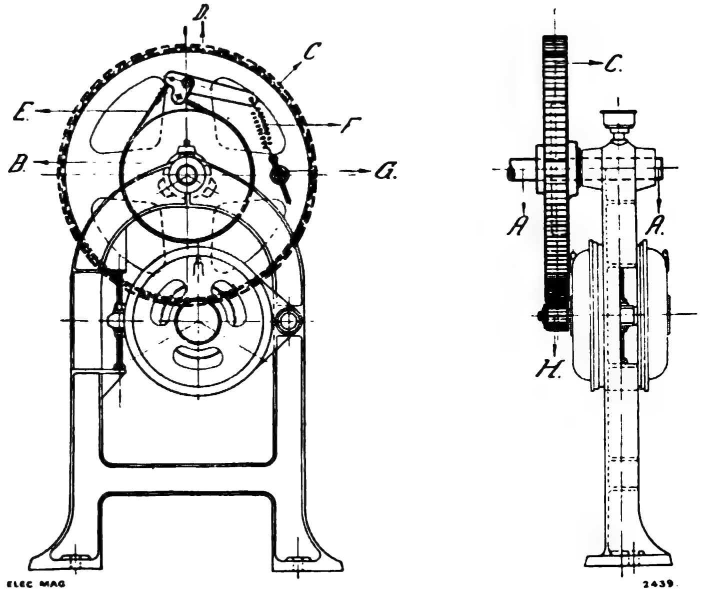
FIG. 25. LARGE LOOMS EACH DRIVEN BY SEPARATE MOTOR.

Fig. 26.

In the illustrations Figs. 29 and 30 further examples of this mode of employing the electric drive are shown. The frames have been made and installed by Messrs. Platt Bros., Ltd., Oldham, who inform us that they have applied single motors for driving all classes of spinning and preparatory machinery, the direct method of drive being employed in every case. In Fig. 30 the motor is shown coupled direct to the tin roller shaft and fitted with a Hele-Shaw clutch. The object of this arrangement is to enable the motor to be started up alone, and by a special arrangement of the connecting parts to allow the machine to speed up gradually until it attains the maximum spindle speed. When the patent clutch is not applied an ordinary coupling, either flexible or rigid, may be substituted, in which case it is necessary to employ some type of slow starting arrangement, otherwise the sudden start may cause breakage of the yarn.

In Fig. 31 a similar class of drive to the one just described is shown. The contractors were the Alliance Electrical Company, Ltd., of London, and they were required to provide for easy alteration of the speed of the spindles from 6000r.p.m to 9000r.p.m. Not only was special apparatus designed to enable this to be done, but it was made possible to start the machine gradually. The machine, it may be stated, was only an experimental one, but the tests that were made at the time were taken in comparison with two other frames of a similar nature in the same room driven by belts. The tests were taken on two separate occasions and extended over four hours each time, the average of each set of tests being given in the table on the next page.

During the test the voltage remained constant at 200. If these results are compared it will be seen that the power taken increases practically directly as the speed, and not (as has been generally accepted) as the square



Figs. 27 and 28.

Revolutions of Spindle.	Revolutions of Tin Roller.	Amperes at 200 Volts.	B.H.P.
5200	514	2.6	.55
6200	612	3.2	.7
6600	652	3.5	.75
7100	680	3.6	.77
8100	768	4.1	.85
9200	880	4.7	1.1

of the speeds. When the two frames driven by straps were tested the following results were obtained: 1. When the counter-shaft was running without the straps which drive the frames the power taken was 2 amps. or 0.48e.h.p. 2. When the straps were put on and running on the loose pulleys the power increased to 8amp. or 2.13e.h.p., or equal to power required to drive the three frames of sixty-two spindles each and gearing at 5200 revolutions by the direct-driven method. This is certainly a surprising result, and when it is pointed out that these tests were not made by the Alliance Electrical Company, but by a recognised expert in cotton machinery, their authenticity cannot be doubted.

The illustrations, Figs. 32, 33 and 34 show electrically-driven machinery at Sir Titus Salt's mills, Saltaire.

In Fig. 32 a set of cotton twisting frames are shown driven by a Westinghouse motor which is placed on the floor and a rope drive transmits the power.

In Fig. 33, Westinghouse motors are shown driving roving frames; in this case the motors are supported from the ceiling, and belts are employed. In Fig. 34, Westinghouse motors of $7\frac{1}{2}$h.p. each are shown, coupled direct to ring spinning frames. It was at this mill that, owing to a demand for finer counts, the owners had to install extra spindles. The only available space to accommodate the ring frames employed was in the basement, at the extreme end of the mill, away from the engines, and it was decided to adopt the individual drive. Twenty-four frames were running at the end of the first twelve months, and lately four more frames were installed, making a total of 28 frames and 10,100 spindles. This is an excellent example of the adaptability of the electric drive.

In the case shown in Fig. 35 the old rope race has been taken advantage of

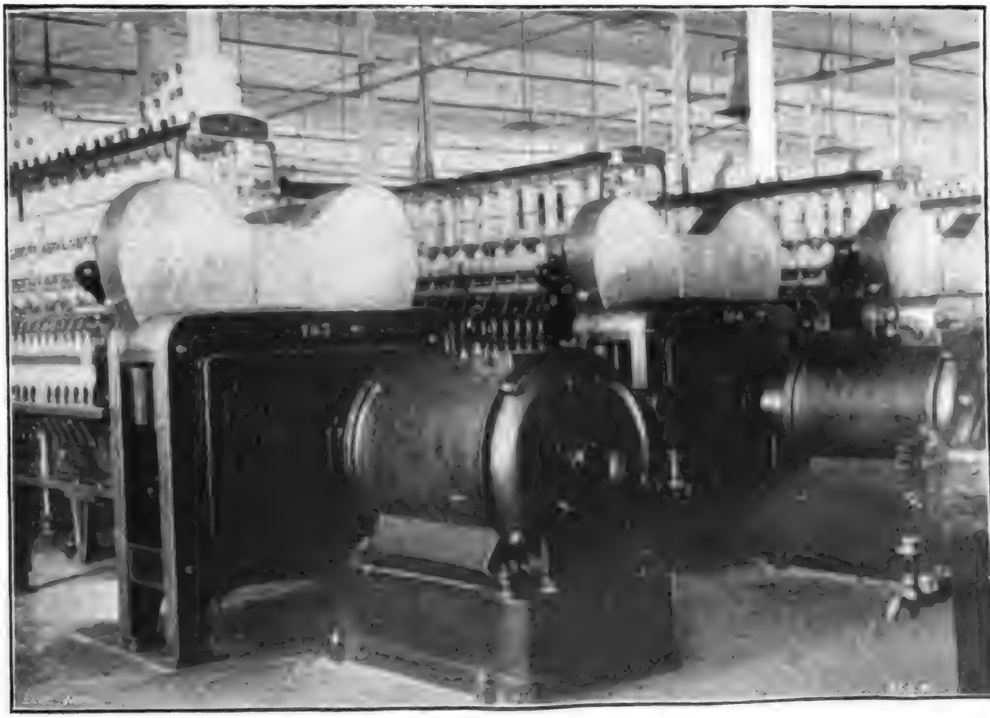


FIG. 29. MOTORS COUPLED DIRECT TO RING FRAMES.

and a motor installed carrying on its shaft a rope pulley which transmits the power through ropes to the various rooms. The motor and installation are the work of the Brush Electrical Company, Ltd., of Loughborough. In Figs. 36 and 37 two views are shown of a weaving shed in which heavy worsted looms are installed. These looms are driven from counter-shafts direct-coupled to electric motors. It is questionable whether looms of this type are better driven in groups or separately. The amount of horse-power consumed in driving such looms is much greater than is required to drive ordinary plain looms, and it is very much a matter of convenience as to whether the driving should be as adopted in the present case, or whether separate motors should be employed. The loss in efficiency in the latter method should not be as important a factor as it is where it is necessary to use small-powered motors.

Another method of driving looms is that shown in Fig. 38, which has been devised by The Electrical Company Ltd., London. It will be seen that the motor is mounted on a separate framing and drives through a pinion mounted on its shaft a gear wheel mounted

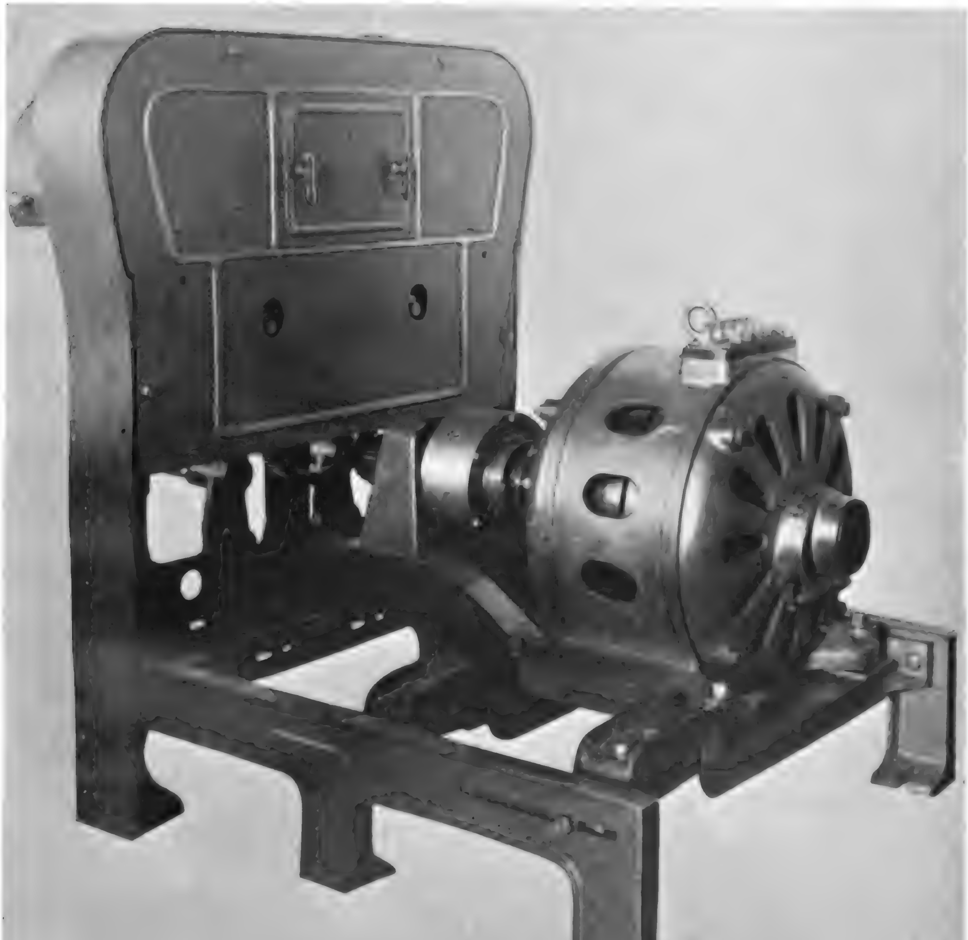


Fig. 30. Motor coupled direct to Ring Frame.

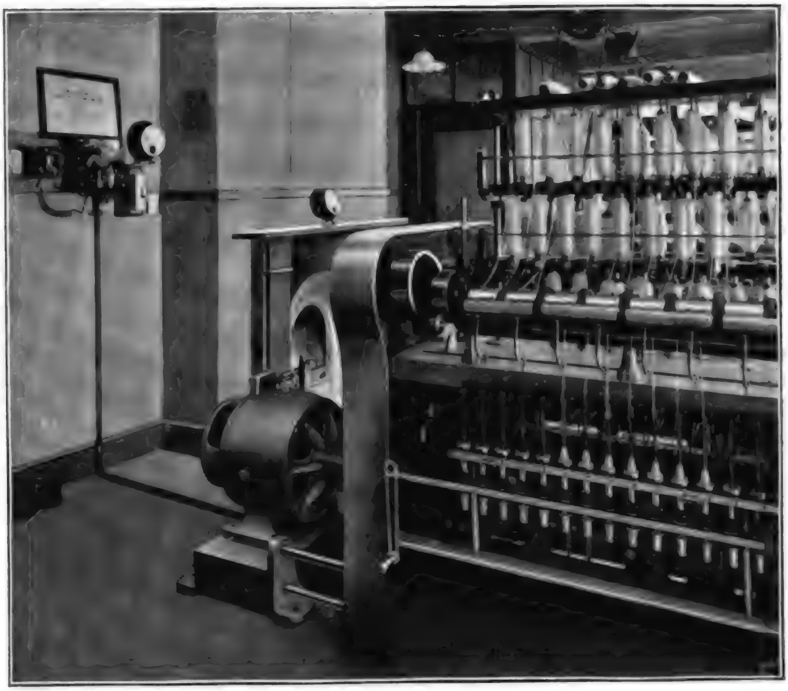


FIG. 31. DIRECT-DRIVEN RING FRAME.

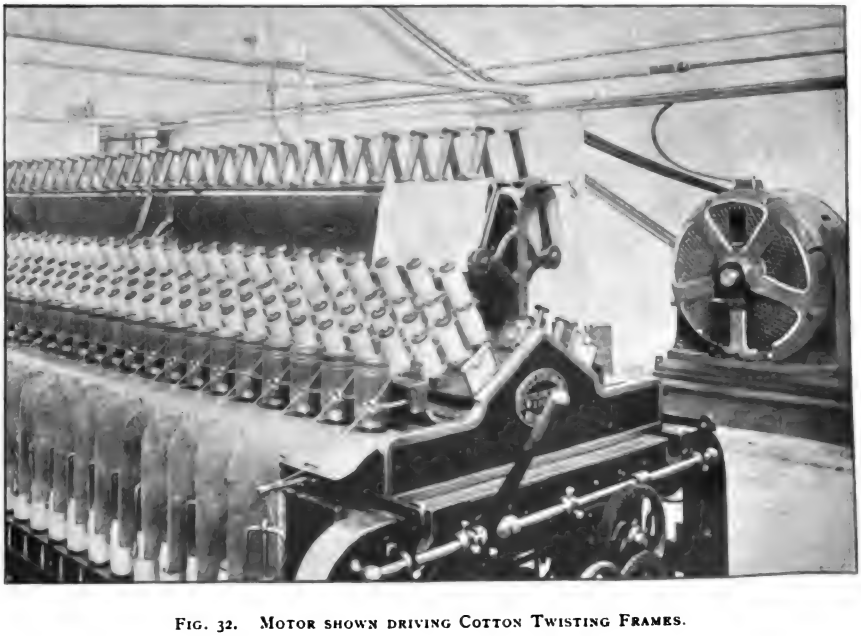


FIG. 32. MOTOR SHOWN DRIVING COTTON TWISTING FRAMES.

FIG. 33. WORSTED ROVING FRAMES ELECTRICALLY DRIVEN.

on the first motion shaft of the loom. The reduction of speed between the motor and the loom is thus easily obtained. Another motor for loom driving is shown in Fig. 39. It will be noticed that in this case the motor, which has been manufactured by the above-named firm, is so mounted that vibration will not affect it. The motor is placed on the floor and drives the loom by means of a belt. It is necessary when toothed gearing is employed to apply special disengaging apparatus so that shearing of the teeth is avoided should the loom stop suddenly through any cause.

Winding machines do not require a considerable amount of power to drive them, and the best method to employ is undoubtedly that of grouping several of the frames together and driving them from a convenient shaft. That is the course that has been

adopted in the case of the machines shown in our illustrations Figs. 40, 41 and 42. The motors in this case have been supplied by Messrs. Electromotors, Ltd., of Openshaw, Manchester. In Fig. 40 a 10h.p. three-phase squirrel - cage motor running at 960r.p.m. is shown driving thirty-three reels together with one or two ventilating fans. In Fig. 41 a three-phase motor with enclosed slip rings is shown driving through a counter-shaft six quick-traverse winding frames of some 670 spindles and also six patent double winding frames of some 750 bobbins. A similar motor is shown in Fig. 42, and behind it will be seen another 5h.p. squirrel-cage motor driving four Rabbeth spindle winding frames. The reeling and winding machinery have been supplied by Messrs. Joseph Stubbs, Ancoats, Manchester.

FIG. 34. DIRECT-DRIVEN RING FRAMES.

The adaptability of the electric motor for small machines is shown in the illustration marked Fig. 43. The machine shown is a single thread tester made by Messrs. Cook & Co., of Manchester, in which six threads are automatically tested for strength and regularity, the results being recorded in diagram form. It will be seen that a small motor is mounted within the frame of the machine and drives it by means of ropes through three pulleys. This arrangement allows the reduction of speed necessary in order to obtain correct results.

From the foregoing descriptions of various

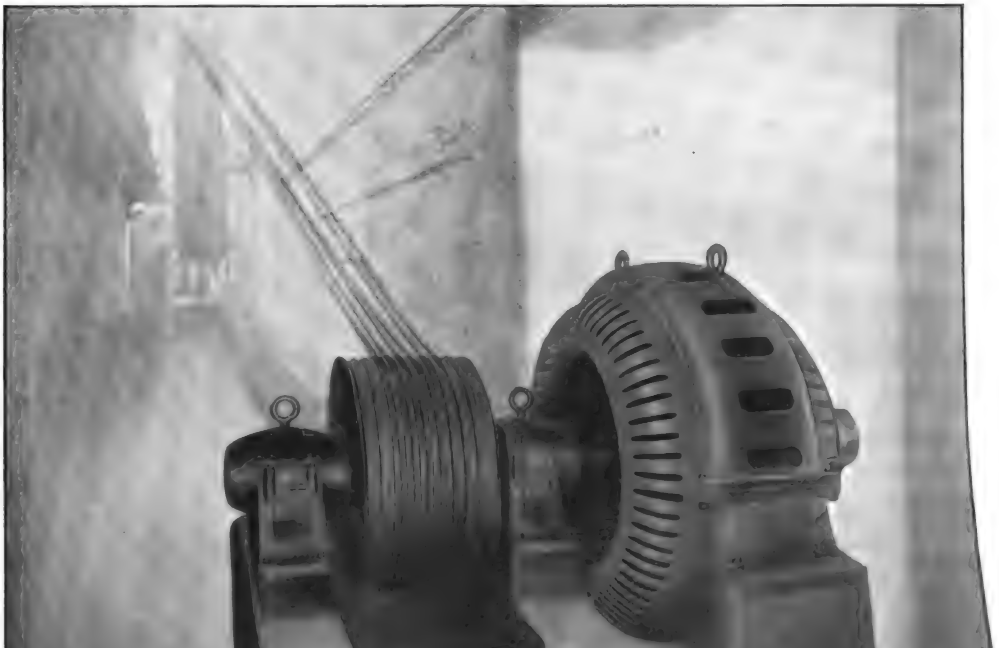


FIG. 35. MILL MOTOR INSTALLED IN EXISTING ROPE RACE.

Fig. 36. Heavy Woollen Looms Electrically Driven

Fig. 37. Heavy Woollen Looms Electrically Driven.

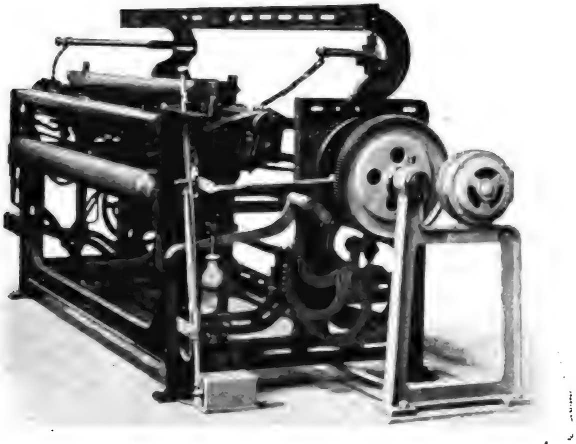


Fig. 38. Electrically-driven Loom.

Fig. 39. A Loom Motor.

drives it must be readily conceded that the electric drive has come to stay. Owing to the short period of time which has elapsed since the various installations have been started, statistics of a reliable nature are somewhat difficult to obtain. Where such data are available, and the figures given previously in this article are instanced, it is shown that as regards cost of driving electricity compares very favourably with other powers. One thing has undoubtedly been proved by the various installations, namely, the extreme adaptability of the electric motor. Another point will be conceded, namely, that in cotton mills the group driving appears to offer the best results. In certain mills and certain branches of the

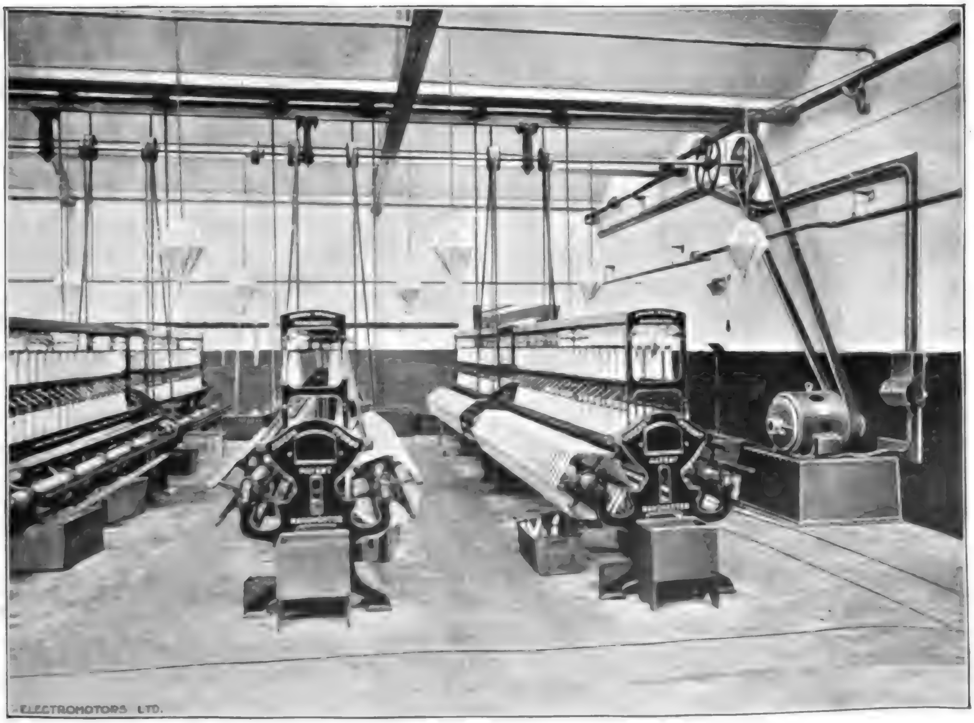


Fig. 40. Three-phase Motor Driving Thirty-Three Reels.

FIG 41. THREE-PHASE MOTOR DRIVING 6 QUICK-TRAVERSE WINDING FRAMES, 670 SPINDLES AND 6 PATENT DOUBLER WINDING FRAMES WITH 750 BOBBINS.

FIG 42. THREE-PHASE MOTOR WITH SLIP RINGS DRIVING QUICK-TRAVERSE WINDERS: SMALLER MOTOR DRIVING 4 RABBETH SPINDLE FRAMES IN BACKGROUND.

industry driving single machines may be not only advisable but necessary, but in the majority of cases driving from counter-shafts direct-coupled to motors appears to be the best method. Where this is done, the loads can be fairly evenly distributed, and thus the wear and tear reduced and the efficiency of the motor maintained at its highest point. The generation of electricity at the mill or the purchase of current from some adjacent power company must depend upon various considerations, chief of which are the cost of the installation to the mill, its current-consuming capacity, and the cost of such current if bought. It has been shown that in one case at least the cost for generating power can be brought down to an extremely low figure.

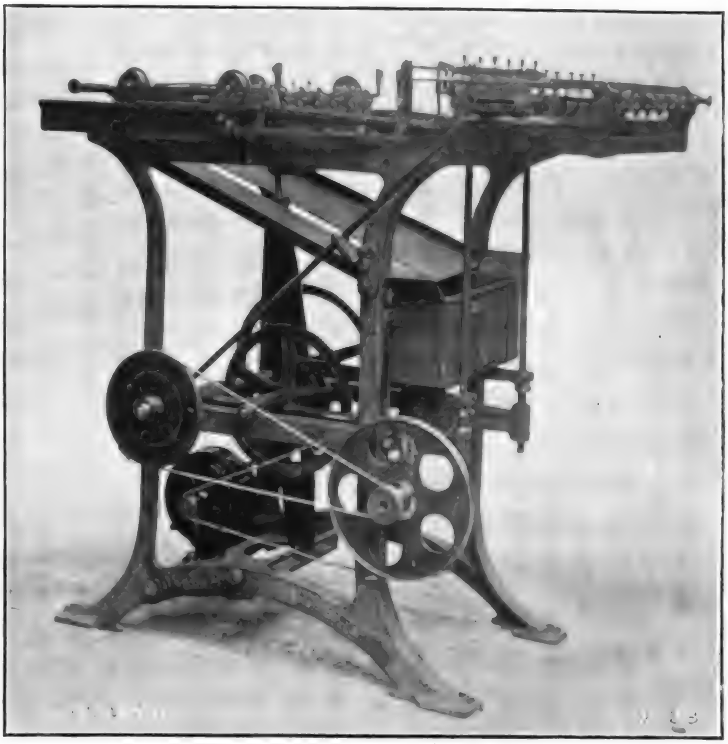


FIG. 43. AN ELECTRICALLY-DRIVEN AUTOMATIC THREAD TESTER.

THE MOORE ELECTRIC LIGHT IN THE TEXTILE TRADE.

W. P. DICKSON.

THE problem of proper illumination for textile products is one which is present from the time the raw material reaches the dyer's hands until the finished article is placed on the market, and at no point in the progress from maker to consumer is there a stage when inferior or deficient light can be tolerated without proportionate loss in the quality of the product and effectiveness of the labour employed. Since diffused daylight is the ideal light for all purposes of manufacture it naturally follows that the artificial illuminant which most nearly resembles the ideal will be the one desired. The hours of useful daylight vary from season to season, and the output of any plant bears a direct ratio to the amount of light available for employés. Science has lent its best energies to the task of taking from the worker the necessity of dependence on variable conditions, which follow the use of natural light, by placing at his command various substitutes. A short account

of the most desirable one will be of timely interest. As the previous issue of this magazine contained a very complete reprint of Mr. D. McFarlan Moore's last American Institute lecture, the purpose of this article will be to point out the particular and exclusive advantages this illuminant has over all others from the viewpoint of the textile manufacturer and dealer. The Moore light emanates from a glass tube $1\frac{3}{4}$in. in diameter, and from 40ft. to 200ft. in length. Thus the first requirement of a useful illuminant, a large light source, is met as in no other, and the resulting diffusion of light is so general that no shadows are discernible. The intrinsic brilliancy is the lowest of any artificial light, hence there is no strain on the eyes of the user, a fact which in itself makes the light invaluable.

The colour of the Moore light varies from pure white to a yellow or orange, the latter being for physiological reasons the more efficient for general illumination. The pure white light is the one of more especial interest to the textile trade, for there is obtainable a positive substitute for diffused daylight, giving the same colour values, not varying from hour to hour as is usually the case with natural light.

The largest silk dyeing plant in America is using this light for matching samples of silks as they come from the vats. Their unqualified endorsement is that all colour values are the same as in diffused daylight.

In the wholesale business dress fabrics are sold under this white light with the assurance that the customer will see just what he is buying and will run no risk in comparison with daylight. In the retail trade ribbons and delicate fabrics are sold under daylight conditions, avoiding numberless journeys to an open door to effect a sale and the delay and confusion incident thereto.

Where before uncertainty of colour values existed in the various stages of manufacture, now there need be no question as to results at any point, for conditions are precisely as though a skylight were used during most favourable daylight hours. The yellow light, while not being the standard for colour values, is used by leading clothing stores with highly satisfactory results, its colour being comparable to incandescent light and the operating cost far less. There are also the added features of perfect diffusion and high efficiency. About 90 per cent. of the customary wiring for an electrical installation is eliminated, consequently fire risks are lessened to the same degree. There being practically no heat to the light, the tube does not affect the temperature of the room in which it is used, nor does moisture or dripping water endanger or impair the usefulness and permanency of the tube. It is the only light ever used directly in contact with water as shown by the installation of a tube several feet under the surface of a fish-tank at a public aquarium. The life of the Moore light is indefinitely long since the conductor is gaseous and renews itself automatically from the air.

A great field of advancement is now open to the textile manufacturer who avails himself of this the latest achievement of electric lighting, which places at his disposal an unvarying substitute for daylight.

THREE "WITTON" MOTORS OPERATING SEWING MACHINE BENCHES.

THE REQUIREMENTS OF THE LINEN, HEMP, AND JUTE INDUSTRIES AS REGARDS ELECTRIC LIGHT AND POWER TRANSMISSION.

H. R. CARTER. (Author of "Modern Flax, Hemp, and Jute Spinning," &c.)

Lighting.

NEEDLESS to say, the question of effectively lighting any textile works is a most important one, and in no kind of textile mill is it of more consequence than in a flax, hemp, or jute manufactory. In the first place, because the air is often thick with dust or vapour and an illuminant which vitiates the atmosphere makes it still more injurious; in the second place, because the dull blay colour of the fibre makes it difficult to distinguish fine threads in the loom or passing to the bobbin on the spinning frame, or light slivers passing over the doubling plate of the spread board or drawing frame; thirdly, because of the great risk of fire owing to the inflammable nature of the dust and flowings thrown off in the dry processes; and lastly, because the fibre is not of the same even quality as is cotton, for instance, and requires careful sorting in the initial stages of its manufacture, especially for the fine sorts.

For the last fifty years manufacturers have been experimenting in order to ascertain what is the best form of artificial light, as reducing the risks of fire to a minimum, as having the least vitiating effect upon the atmosphere, and as being the artificial light most nearly approaching the natural light of the sun. It is now quite twenty years since electricity, of course as a source of light, was first introduced into a North of Ireland flax mill, and it was probably some years later before it was adopted in any other branch of the linen, hemp, or jute industry. At that time the writer was serving his apprenticeship in a country mill which was, he believes, the second firm engaged in flax-spinning in the North of Ireland to adopt the electric light. He well remembers the wonder of the natives when the current was first switched on to the spinning room and the sage remark of the "handy man," that he had heard it said that a mixture of gas and electricity gave a still better light.

A short time afterwards the author had the advantage of being present at a lecture given by Mr. J. H. Greenhill, Belfast's pioneer electrical engineer, before the members of the local Philosophical Society, in which the lecturer pointed out the similarity between the laws governing the flow of the electric current and those relating to the flow of water both as regards volume and pressure, and stated that electricity "was as easily measured as buttermilk."

The writer's interest in the subject thus awakened, he has followed each stage of its advancement in the textile industries, and, as a manager at home and on the Continent, has, since that time, had many opportunities of studying its utility in mills and factories, both for lighting and as applied to power transmission.

Lighting by electricity is now almost universal in modern mills and factories, although some small old-fashioned and out-of-date spinning mills, factories, and bleach-works are no doubt still lighted by gas. The current is usually generated by a dynamo driven by ropes or belt from the second motion shaft and the current distributed from a main switchboard to the various departments of the mill. The incandescent lamps are generally connected up in single or series parallel, the three-wire system being also sometimes adopted. In wiring up a long spinning room care must be taken that it is arranged in such a way that the circuit formed through any one lamp is of approximately similar length to that of the others, so that the intensity of the light at the end of the room farthest from the dynamo is not diminished, or so that it may not be necessary to increase the voltage to the degree required to give sufficient light at the end of the room and thus shorten the life of the lamps nearer to the generator; 110 volts is the usual pressure employed. Both arc and incandescent or glow lamps are used in flax, hemp, and jute mills and factories.

A great objection to arc lamps in prepar-

ing rooms, &c., is that in many cases the belts and overhead gearing are in the way, and a good position for the lamps cannot be found, as they must be suspended at a fair height lest the light should be too much localised. As now made, arc lamps do not necessarily give that greenish-white light which was a feature of the arc light of twenty years ago. Arc lamps are now in the market in the light of which colours can be distinguished as readily as they can be in a good north light. Such lamps may be successfully used in hand hackling and sorting shops, but may be advantageously supplemented by the more concentrated light of an incandescent lamp placed in front of each sorter's tools. Enclosed or double-globe arc lamps are the best suited to the requirements of a textile mill. In the first place, they may be run separately on a 110-volt circuit, whereas ordinary arc lamps must be fixed in pairs in series. Their light is better diffused than that of the ordinary arc lamp. It is not necessary to recarbon them more frequently than every 150 to 200 burning hours, which, so far as mills are concerned, means only once or twice a year. There is no possibility of red-hot pieces of carbon falling from the lamp upon the work below, for the carbons are completely enclosed in a special form of globe. They are much used in American textile mills.

For fine spinning rooms the incandescent lamp is to be preferred, two or three being placed in each spinner's stand at a height of about four feet above the floor level. Arc lamps, which, of course, take less current for a given candle-power produced, and which consequently give the cheapest light, do very well and may be advantageously used in machine hackling rooms, shed rope works, bleach and dye works, where a good general light is required. When a more concentrated and localised light is needed, as upon the rollers, thread-plate and bobbins of a spinning frame, incandescent lamps are to be preferred, as they may be hung so as to throw their light exactly where it is required. In connection with the fine wet spinning-room, where a strong concentrated light is required upon the bobbin and thread-plate of the spinning frame, it may be noted with regard to the height of the lights that one lamp at 3ft. distance will illuminate a surface as well as four lamps at 6ft. distance, and consequently the lamps should not be placed higher than is necessary, the same remarks applying to lighting in general. It may also be noted that by means of surfaces which reflect light the effective candle-power of the lamp can be very materially increased in a particular direction at the expense, of course, of the effective candle-power in other directions. A mirror will reflect 95 per cent. of the light which falls upon it, and a smooth white surface about 80 per cent.

As an apprentice the author tried to take advantage of this circumstance and designed a sort of tin cage in which the lamp was held horizontally and was surrounded by reflecting surfaces of tin arranged at the correct theoretical angle to concentrate the reflected light upon the required area, *i.e.*, a band about 18in. broad, stretched from one end of the frame to the other and extending from the builder, at its lowest position, to the lip of the hot water trough. Although succeeding in a certain degree, his efforts were not completely successful owing to the source of light being a spirally coiled filament and not the horizontal luminous line upon which he had based his design. A tubular form of lamp is now made, with an axial filament sealed into its ends, which might be used for this service to throw out light over the required area on both sides, means being provided to keep the lamp and its surrounding reflectors from swinging. He offers this suggestion for what it is worth.

Lamps hung so low as has been suggested must be hung up to a more convenient height when not in use. Any elaborate apparatus by means of which they may be raised and lowered is usually considered as too expensive and out of place in the mill. In consequence, a cord is generally attached to the lamp socket and formed into a loop by means of which the lamp is hung up against a column or attached to another lamp, drawn in the opposite direction. There is much room for improvement in this respect, as the constant friction of the wires against the socket, which is often unprovided with a wooden bush, frequently wears away the insulation and allows current to enter the socket and reflector, which current gives an unpleasant shock to anyone touching the shade or socket while standing upon the wet floor, if it does not cause a short circuit, melt the fusible wire of a cut-out, and plunge a whole stand in darkness.

The successful wiring of the wet spinning-

room is fraught with many difficulties owing to the dampness of the atmosphere, its fire-proof construction, windows reaching to the ceiling, walls and ceiling running with moisture, the line-shaft extending down the room and drums and belts close to the ceiling, the belts running over guide pulleys close to the side walls. It is most successfully accomplished by stretching the wires between porcelain insulators attached to wrought-iron brackets grouted into the walls and ceiling, the lamps being hung in a similar manner. The main wires are sometimes bare and carried outside the building.

As already stated, either two or three lamps may be provided for each spinner's stand, according to the length of the frames, which run from 19ft. to 28ft. Each lamp is usually of either 16c.p. or 20c.p. The latter are recommended, as a manufacturer will be well repaid for giving plenty of light in the spinning-room. Lamps of 16c.p. will give sufficient light in the preparing-room if they are ranged in rows down the main passes and placed opposite the frames at the rate of one for every two heads of drawings or for every three heads of rovings. They should never be hung actually over the frames or backs lest a breakage should occur and the glass fall into the cans or gills.

Incandescent lamps are also the most satisfactory for all departments of the weaving factory. For narrow looms, say up to 56in. R.S., one 16c.p. lamp per loom will be found sufficient. It should be suspended above the loom rather in front of the arch and high enough to be out of the weaver's way, and in such a position that no shadow is thrown upon the shed or the fell of the cloth. For wider looms than those of 56in. R.S., two lamps of the same power are necessary. For cloth-passing, yarn preparing, &c., the absence of all shadows is desirable, and can be most easily obtained by the use of a number of small lamps rather than a few big ones.

Economy may be effected by the use of arc lamps in the yard, engine-house, bleach and dye works, finishing works, and in rope

FIG. 1. A TYPICAL OLD-STYLE MILL ENGINE.

F.

works, where, on account of the nature of the work, a good general light is all that is required.

Arc lighting is one of the cheapest forms of artificial light. An arc lamp requiring 500 watts will give a general light valued at 1000 candle-power. Incandescent lamps absorbing the same number of watts will only give 125c.p., but the light may be better distributed or concentrated if necessary for any special purpose. The most serious disadvantage of arc lamps is their uneven distribution of light and the attention which the ordinary forms require. Inverted arc lamps are admirable where a soft and shadowless pure white light is necessary, and are especially valuable when the ceilings are low. They prevent the casting of heavy shadows to some extent, but require a very white ceiling, which is often not easily obtained, especially in flax mills. Arc lighting of the proper sort does not falsify colours, a point of much importance in dye and bleach works, where the true discernment of colour and shade is essential.

A set of accumulators should be installed to provide current for a few lamps for use at any time when the main engine is stopped. Accumulators can only be employed with a continuous-current installation, as they cannot be charged by means of an alternating current.

Power Transmission.

Electricity's true position for power purposes is that of a transmitter. Although the application of power transmission by electricity continues to extend and is now being used in many textile industries in America, Italy, Russia, France, Germany, Belgium, and Switzerland, there are but few applications in the linen, hemp, and jute industries. The reason is no doubt in part due to the fact that until quite recently these industries have been in rather a depressed condition as compared with the cotton industry, and manufacturers have had to make their old engines and gearing, such as are shown in Figs. 1 and 2, serve, not caring or being able, in some cases, to invest in a more modern plant, although working most uneconomically very often. Although trade

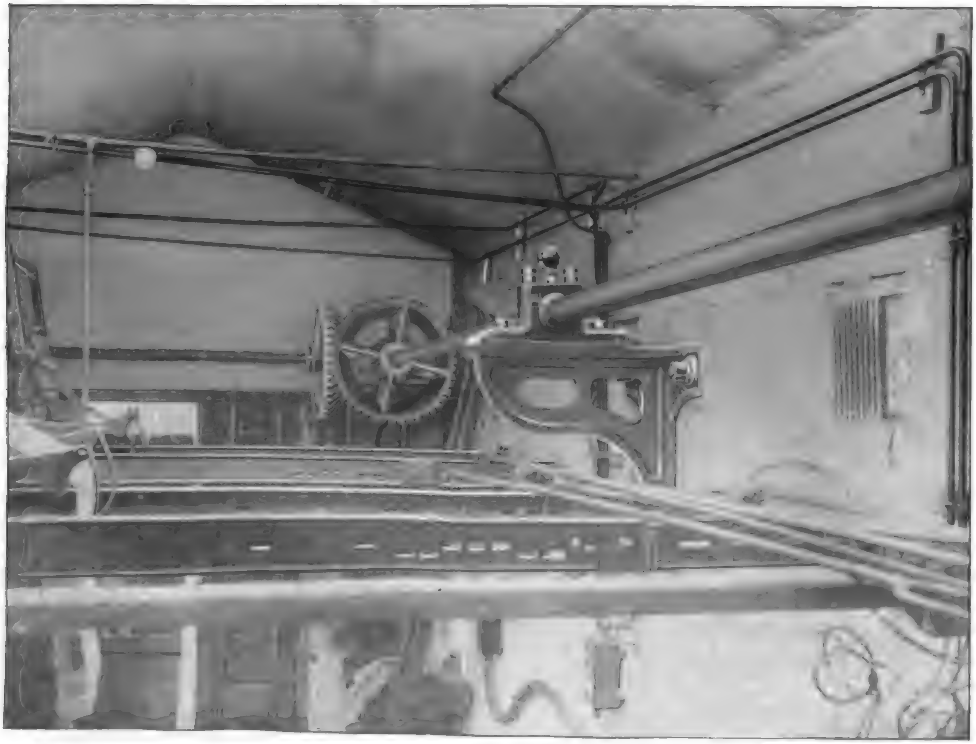


Fig. 2. An Old-style Power Transmission.

is now abnormally good, they fear that the boom will not last and that a slump will come, as it has done before, and are consequently afraid to extend. Where extensions have taken place the electric current has in some instances been employed to transmit power to drive those extensions. Some of the most important applications in flax, hemp, and jute mills and factories in Great Britain and Ireland are the following :

Four 100h.p. three-phase motors driving the shafting in the jute-spinning mills of Messrs. Cox Bros., Dundee.

One 100h.p. motor and suitable direct-current dynamo driving the shafting in Messrs. J. Prain & Sons' jute-weaving shed, Dundee.

One 40h.p. and two 30h.p. motors operating bale opening and softening machines, drawing and roving frames in Messrs. Kidd & Co.'s jute mill, Dundee.

Two 150kw. direct-current generators and two 80-h.p. motors driving the calendering department of Messrs. Malcolm Ogilvie & Co.'s jute works, Dundee.

About 150h.p. in motors in the Victoria Spinning Company's works, Dundee. All the above have been supplied by the British Westinghouse Electrical Company.

In answer to an inquiry, Wm. Young, Esq., of the Irish Flax Spinning Company, Ltd., Belfast, kindly replies to the effect that they have three departments driven by electric power and find it satisfactory. Dynamo and motors work well and have given no trouble since they were started some three years ago.

Messrs. J. & W. Knox, Ltd., of Kilbirnie, have also their flax wet spinning department driven by electricity with satisfactory results. The writer has knowledge of but one flax or jute mill in which main power transmission by means of ropes or gearing has been entirely dispensed with and electrical power transmission adopted. He refers to Messrs. Birkmyre Bros.' new jute mill on the River Hugli near Calcutta.

This installation was carried out by the British Westinghouse Company ; the motive power is generated by steam turbines. The main turbo-generators are each of 1300kw. capacity, and furnish

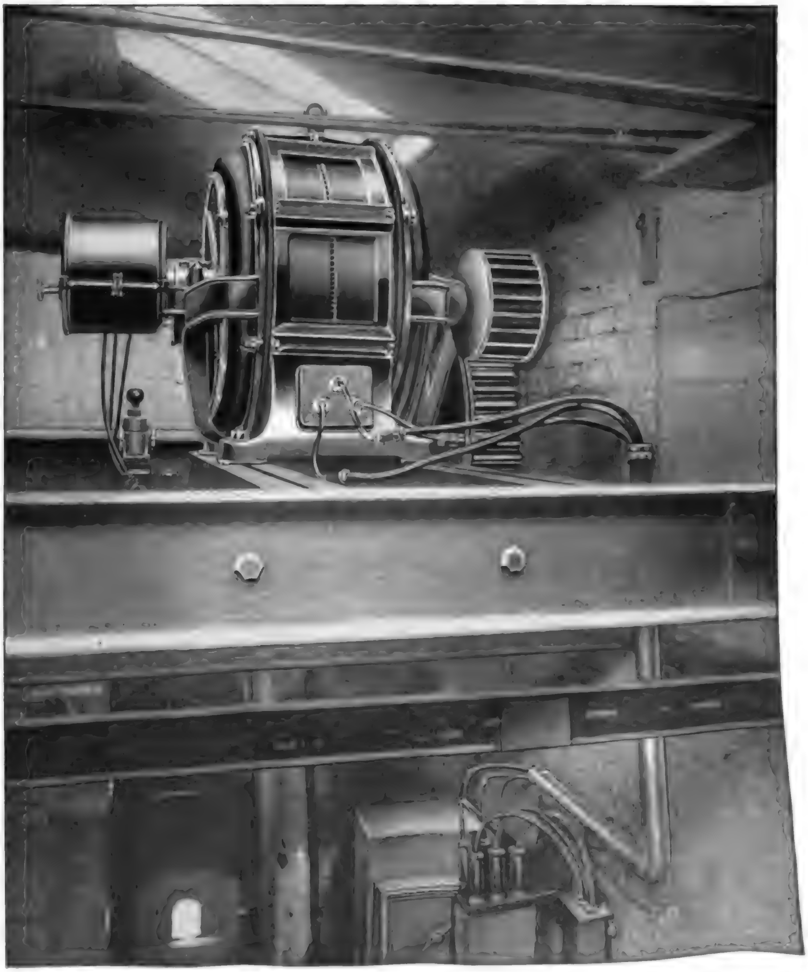


Fig. 3. Motor Geared to Shafting for Group Driving.

three-phase current at 440 volts pressure, and a frequency 25 periods per second. The greater part of the driving is done by three 700h.p. motors running at 290r.p.m. and direct coupled to the main shafting.*

The advantages of electric driving are simplicity and flexibility of the plant, and steady and uniform driving. By the use of the polyphase alternating current system, which is usually used in the three-phase form, and with the motors directly connected to the shafts, it is impossible for any appreciable variation in speed to take place on the driven shaft unless the engine or turbine connected with the electric generator should vary in speed.

Electric motors require practically no attention, as the lubrication is automatic and the oil in the bearings need only be renewed every few months.

When electric driving is adopted any loom or group of machines can be operated independently. This is invaluable for overtime work, as, for instance, when it is desired to run the preparing at night, which some firms are now doing, in order to be able to spin with shorter drafts or to increase the number of spinning spindles. In the old way much waste of power would be involved if the whole system of heavy belting and shafting throughout the mill had to be turned. A change from steam to electric driving may be made without a single hour's stoppage. The electric drive may be most economically resorted to for the replacing of such obviously inefficient cases as where there are as many as six line shafts belted together in such a way that all the power required on the sixth shaft is transmitted through the other five, with consequent excessive waste of power, the slip on the first belt being transmitted in increased ratio to all the other belts.

In connection with the electric drive power records may be taken, providing a form of automatic supervision, from which the manager can see at a glance whether

* Further details and illustrations of this installation are given on pages 31-33.

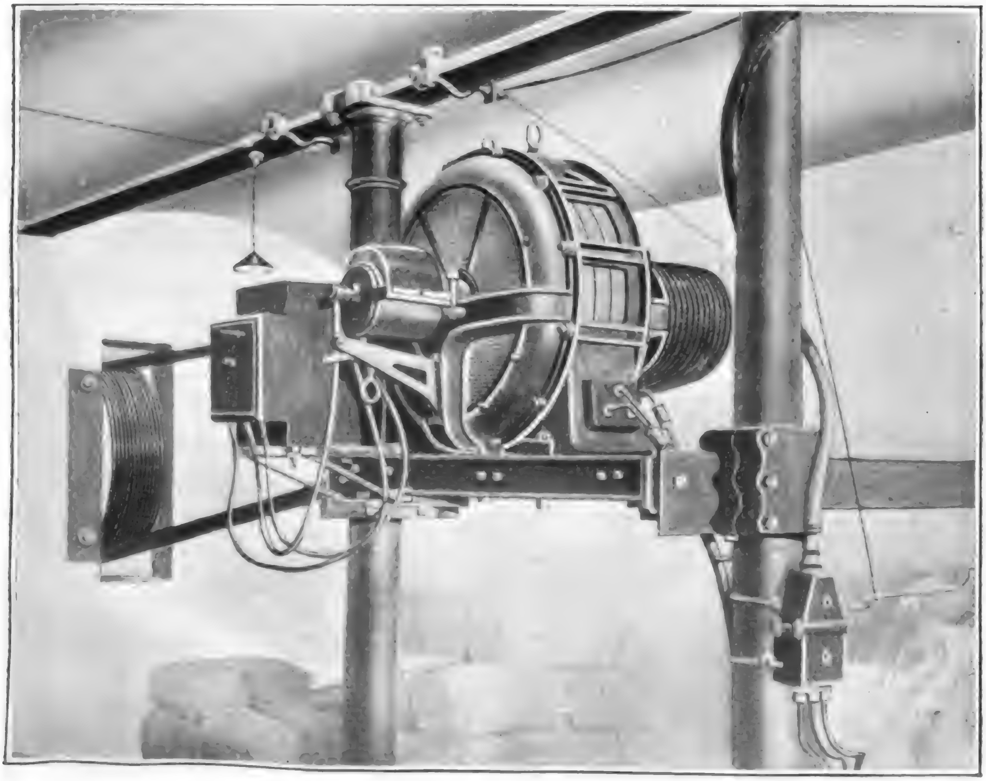


FIG. 4. MOTOR DRIVING SHAFTING BY MEANS OF ROPES.

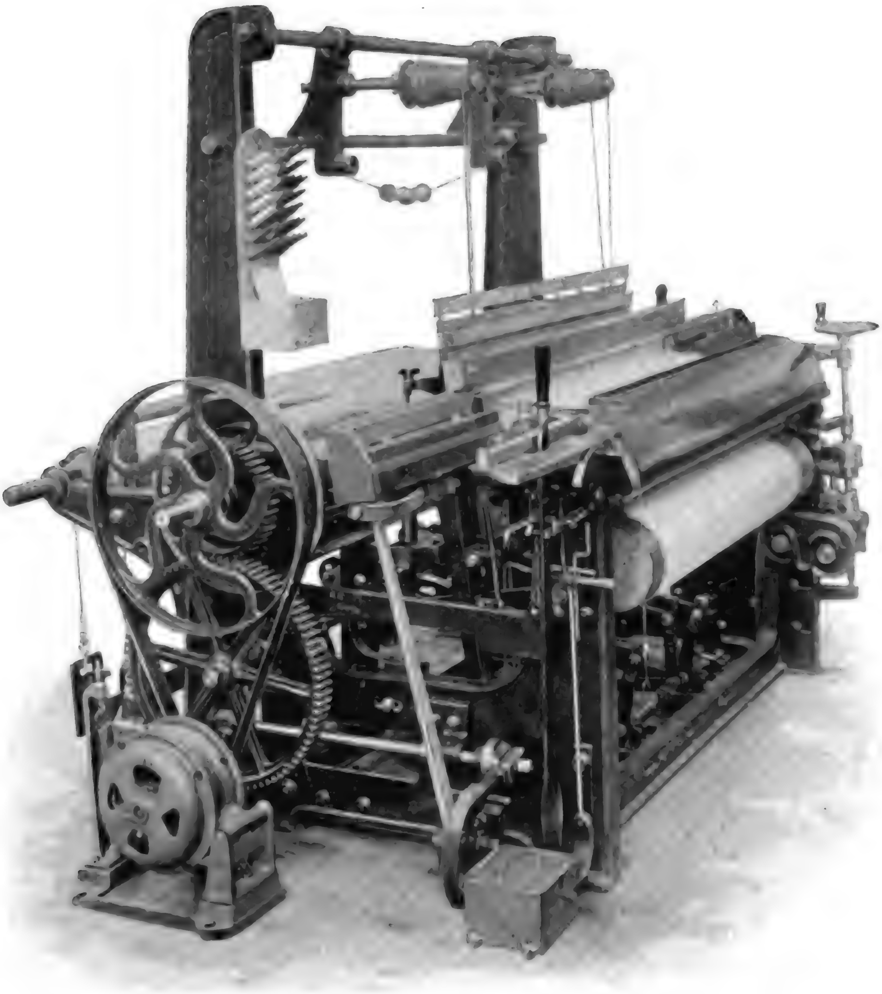


Fig. 5. Motor Driving a Loom.

anything unusual has occurred, such as a number of frames stopped at the same time or if any particular machine is absorbing too much power.

The importance of a uniform and steady drive for spinning in general must be specially emphasised in the case of flax, hemp, and jute spinning. These fibres have not the elasticity of cotton or wool and are consequently more difficult to spin and more liable to breakages if the maximum speed be surpassed even momentarily. A variable speed would not, of course, be so injurious were not spinners nowadays obliged to obtain the maximum turn-off by running their spindles at the highest speed which the material will stand. Six thousand to 7000r.p.m. of the spindles is probably the maximum speed of the wet spinning frame, and corresponds, according to the usual practice, with a speed of 600r.p.m. to 700r.p.m. of the tin cylinder of the spinning frame, or say 200 to 250 revolutions of the line-shaft. Other maximum mill and factory speeds are 200r.p.m of the card cylinders, six lifts of the head per minute for hackling machines, 300 drops of the fallers per minute on gill drawings and rovings, 1000r.p.m of roving spindles, 4000r.p.m. of the spindles of dry spinning frames, 1600r.p.m. of the flyer of automatic spinners, 240 picks per minute of the loom, 90 yards per minute off stenter,

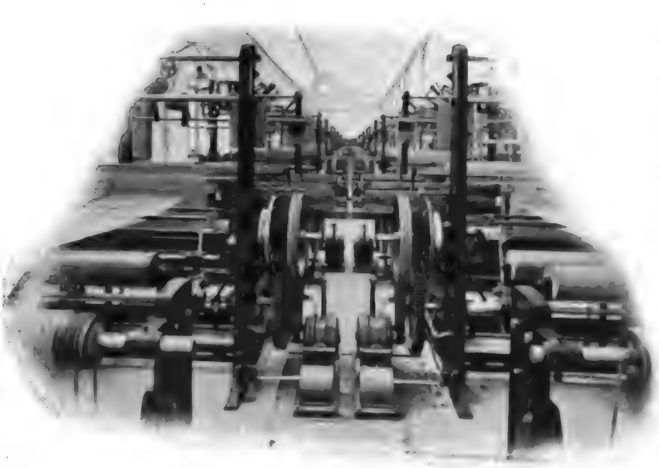


Fig. 6. Motors Driving Looms.

and 40 yards per minute off friction calender. These speeds usually necessitate a maximum line-shaft speed of 200r.p.m.

A motor running at the slow speed of 200r.p.m. and directly coupled to the line shaft would be of large size and very expensive, so that a smaller and cheaper high-speed motor is generally used, and which, running at say 600r.p.m., is connected with the shaft by reduction gear, as is shown in Fig. 3, or by means of ropes as seen in Fig. 4. When gearing is used, the driving pinion may be of raw hide, to reduce noise, and the driven wheel of cast steel. In every case the motor may be fastened to the ceiling or supported overhead, as shown, to economise space.

When the motor drives a shaft which communicates motion to a number of machines, the group system is said to be adopted. The individual system consists in the application of a single motor to each machine and in dispensing entirely with the use of ropes, belts, gearing, and shafting between the dynamo and the machine to be driven.

The group system has many advantages, particularly in the case of the conversion of existing mills from the mechanical to the electrical system of driving. In such cases the existing line shafts may be divided into suitable sections and a motor connected with each section. If the group system is adopted, it should be so arranged that each group requires approximately the same power. Motors of similar size and make may then be employed, and a spare armature and field coil for each size of motor kept in stock, so that in case of a breakdown the minimum of inconvenience is experienced.

Fig. 7. Motor arranged for the Individual Driving of Looms, &c.

Fig. 8. Details of Small Motor for Individual Textile Machine Driving as made by the Maschinenfabrik Oerlikon.

Owing to its cost, the individual system has found little favour in the textile trades. It has its advantages, however, in certain cases, and has been applied to the driving

Fig. 9. Calender Individually Driven by a British Electric Plant Company's Motor.

of both spinning frames and looms. In the case of the flax, hemp, and jute spinning frame, it is the custom to run the frame slowly after doffing until it has been got into order again and until the first layer of yarn has been put on the bobbin. This slow speed is produced in the ordinary way by holding the belt fork so that the belt is half on and half off the fast pulley, so that it slips and produces an irregular slow speed. A higher speed than the normal might also be given to the frame when the bobbin is half-full, as it is at this time that the spinner's work is lightest, the speed being diminished again, if necessary, as the bobbin fills, an increased production being thus obtained. Sometimes the weather is propitious, or a good spinner is on the frame, and increased production is possible if the speed be increased, for the time being, quietly and without the changing of pulleys and pinions, which the spinner resents. Practical spinners will know what is meant. All this has been done and is possible with an individual direct-current motor for each frame, the regulation of speed being left to the spinning master, who is given a bonus on turn-off.

Although small motors are of comparatively low efficiency, they may sometimes be advantageously applied to looms, as shown in Figs. 5 and 6, a better light being obtainable in the day-time owing to the absence of belts, and a better and more uniform turning moment obtained, producing a better cloth. No especial modification of the loom is required to fit it for electric driving, any loom constructed for belt driving being suitable, starting and stopping being effected in the same manner and with the same mechanism as in ordinary belt driving.

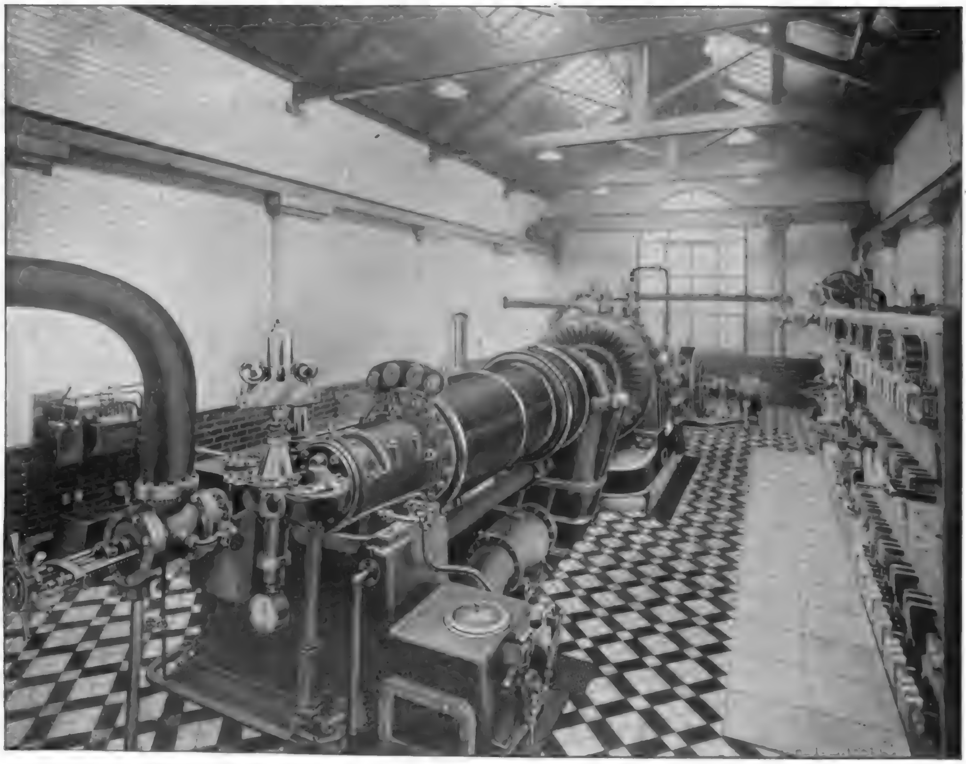


FIG. 10. TURBO-ELECTRIC GENERATOR AS INSTALLED BY DRAKE & GORHAM, LTD.

A motor particularly suited to loom driving, and in general use on the Continent, is shown in Fig. 7. It is of the three-phase type by the Maschinenfabrik Oerlikon, whose representative in this country is Mr. G. Wüthrich, Oswaldestre House, Norfolk Street, London. It is fastened to the floor so

that its pulley is below the driving pulley of the loom, the tension of the short belt being maintained in a simple manner by the weight of the motor itself. Fig. 8 shows the parts of the motor in detail.

The Westinghouse motor of the squirrel cage rotor type may also be used for the direct driving of spinning frames, looms, &c. In this motor the rotor is short-circuited and there are no external rings, so that the chances of sparking are entirely obviated, especially as no commutator or brushes are required. Fig. 9 shows how a motor may be applied to a calender. In this case the equipment was provided by the British Electric Plant Company, Ltd.

More than a decade ago the electric stop motion which has been used in the cotton trade was adapted to the flax and tow drawing frame by a North of Ireland spinner. The invention referred to was designed to call the attention of the drawer when a "choke," lump, or thin place occurred, or when a lump or thin place arrived at the back of the drawing-roller, and at the same time to stop the frame by shifting the driving strap from the fast to the loose pulley. The pushing forward of the loose conductors by such an accumulation completed an electric circuit, exciting an electro-magnet, ringing a bell, lifting a catch and allowing the belt to be pulled upon the slack pulley by means of a spring attached to the belt fork. Although used in the cotton trade, such stop motions have never found favour in the eyes of flax spinners, although they might be very useful in sounding a bell when a slive runs out or breaks or as a warp stop motion in the loom, &c.

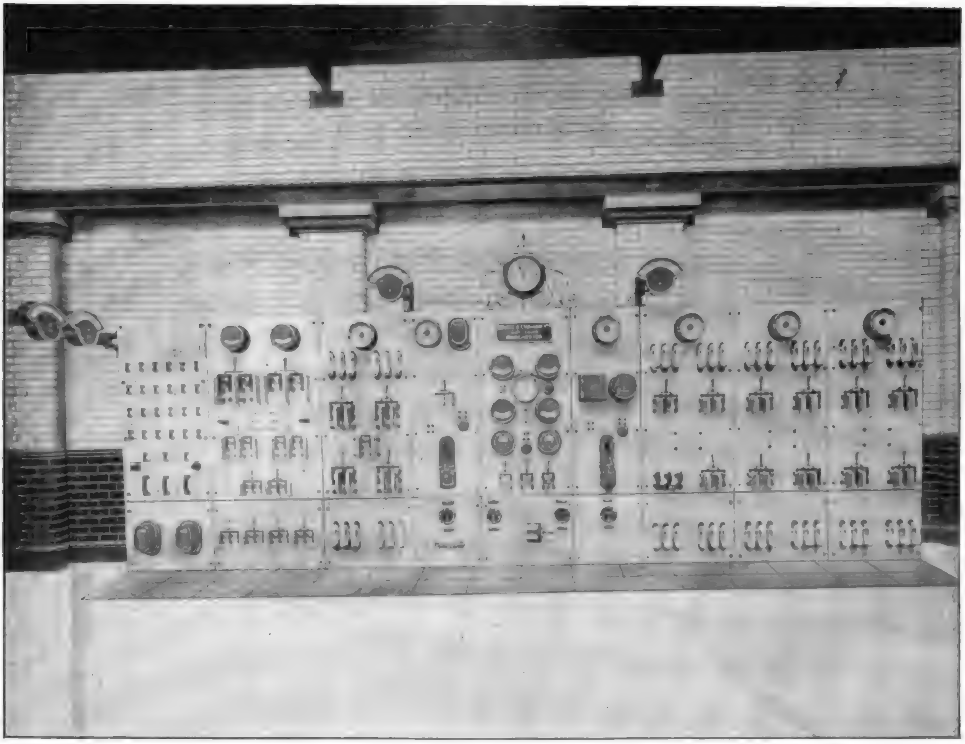


FIG. 11. MAIN SWITCHBOARD FOR CONTROLLING THE ELECTRIC CURRENT FOR LIGHT AND POWER, AS SUPPLIED BY DRAKE & GORHAM, LTD.

There are several ways in which the electric current may be obtained. In certain centres, current may be purchased from an electric station at as low a price as three-eighths of a penny per unit. At this price it would be more advantageous to take the current in this way than to put down the plant necessary to generate it for one's own use. When the current is provided by a central station it is sometimes transmitted

at as high a pressure as 10,000 volts, and must be transformed to a much lower pressure, say 400 volts, before being distributed to the motors.

When the current is generated within the mill a high-speed engine or steam turbine may be directly coupled to a three-phase alternator, as seen in Fig. 10, which represents a recent installation carried out by Messrs. Drake & Gorham, and the current led off through the switchboard to the various constant-speed induction motors which are attached as closely as possible to the point of application of the energy.

Alternating-current motors commend themselves particularly for service in dusty rooms on account of their elimination of sparking and the resultant reduction of fire risk.

Fig. 11 shows a main switchboard fitted with all the necessary meters for measuring the amount of current, and all switches for controlling the whole of the motors and lighting of a direct-current installation. Starting switches are fixed on the wall below the motors. The usual starting switch has a number of steps or contacts, with resistance coils mounted at the back. The operator, in starting, moves the lever slowly and gradually across the contacts, cutting out more and more resistance from the armature current and increasing the speed of the machine. The starting switch is arranged so that if the supply of current fails for any reason, such as the stopping of the generator, for instance, the lever will fly back to its "off" position. It is magnetically held in its "on" position by means of a small magnetic coil energised by the shunt current of the motor. Should the supply fail, this electro-magnet loses its power, and a spring comes into action, causing the lever to fly back to the "off" position. Such an arrangement protects the motor from any possible injury by a rush of current on restarting the main current supply.

The power required to drive a medium to fine flax spinning mill may be taken at the rate of 1h.p. per twenty spinning spindles. For jute and hemp spinning mills the number of spindles per horse-power will be considerably less.

ILLUSTRATION SHOWING TWO OF THE DIRECT-CURRENT ELECTRIC MOTORS INSTALLED BY THE GENERAL ELECTRIC COMPANY AT A BELFAST LAUNDRY FOR DRIVING SEWING MACHINE BENCHES. EACH MOTOR IS OF ABOUT 25H.P.

AN ELECTRICAL PLANT AT A BLEACH AND PRINT WORKS.

By an Electro-Textile Specialist.

At the particular works under notice for some four years past as opportunities presented themselves the old fashion has been giving place to the new, until now the whole of the machinery in the several departments is driven by electric motors with very few exceptions. A description of the general arrangements and illustrations of some of the rooms will be found of interest and value to those engaged in electric power and textile practice. The contractors for the new power equipment were Messrs. Mather & Platt, Ltd., of Manchester, who have been very closely identified with the recent boom in electro-textile business.

The engine room (see Fig. 1) contains three steam dynamos, each capable of developing 150kw. at 220 volts. The engines are by Mather & Platt as well as the dynamos, the former being of the open marine type, with crankshaft governors, running at 185r.p.m. They are supplied with steam at 100lb. pressure from the old boilers formerly used to supply the various small steam engines scattered about the works, and which have been now retired from service in favour of electric motors. The dynamos are six-pole direct-current machines, compound wound and of the usual standard construction; the two older dynamos have now been in steady operation for above four years without any appreciable wear on the commutators, and with the original sets of carbon brushes still in use.

Against one wall of the engine room is fitted the main switchboard, there being three dynamo panels each provided with the usual switches, circuit-breakers, and instruments; and two feeder panels each for four circuits, the several circuits being separately allotted to individual departments of the mill. The feeder cables consist of taped and braided conductors; they are run on porcelain insulators carried by oak arms affixed to the outside walls of the buildings, and they terminate in each section at a distribution board fitted with switch-type fuses. The wiring from the distribution boards is carried out with insulated wires, which, however, are also carried on porcelain insulators except where they are within reach of the workmen, when they are placed in steel conduits.

In carrying out this installation several difficulties had to be overcome; in order that the output of the works might not be interfered with, the motors had to be adapted to the textile machines as they stood. The result is that perhaps in some cases better drives could have been obtained had it been possible to alter radically the position of some of the textile machines.

The processes undertaken at the works consist of bleaching, dyeing, and printing, and each of these occupies a separate department; but preliminary to all of them is the singeing machine, which is belt-driven by a 5h.p. motor of the entirely enclosed type. By the side of this motor, in addition to its own controller, is a second controller connected to the motor driving the grey washing machine in the bleach house. It is thus possible to control the latter machine from the singeing machine when pieces of cloth are being passed directly from the one to the other.

In the bleach house there are in all twelve electric motors, some of which are shown in the illustrations Figs. 2 and 3.

Fig. 1. The Electric Generating Plant.

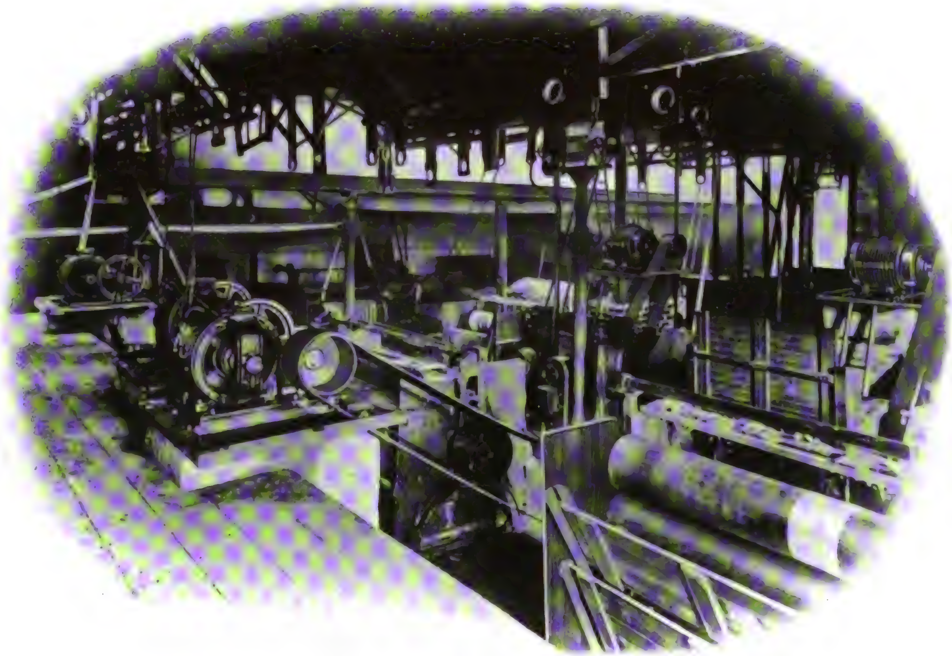


FIG. 2. THE BLEACH HOUSE.

In every instance the machines here are individually driven, the motors are fitted with raw hide pinions, and are of the back-geared type, for reducing the speed before driving on to the machine by belt. The floor space available being very restricted, it was in several instances necessary to build up brick piers eight feet high on which to mount the motors so as to obtain a sufficient length of belt drive. The conditions obtaining in a bleach house, with clouds of steam continually rising, are very trying to the electric motors. In consequence of this fact, and as a further precautionary measure, they are in many instances lodged in wooden housings, besides being of the entirely enclosed type.

The liming machine takes the least power, and is driven by a $6\frac{3}{4}$h.p. motor, the chemic and souring machines have each a $9\frac{1}{2}$h.p. motor, while the several washing and squeezing machines are each driven by a motor of 11h.p, and finally the alkali pump is provided with a larger motor of 19h.p. Each motor is provided with a circuit-breaker and a specially-designed controller with oil-immersed resistances for giving variable running speeds. The speed regulation is capable of the nicest adjustment, which is most necessary since the cloth has to be passed through several machines in succession without touching the ground, and the diameter of the bowls of the machines is always liable to slight variation through wear. Adjacent to the bleach house is a beaming machine driven by a 5h.p. motor through belt.

Following the course of the cloth from the bleach house we pass to the drying

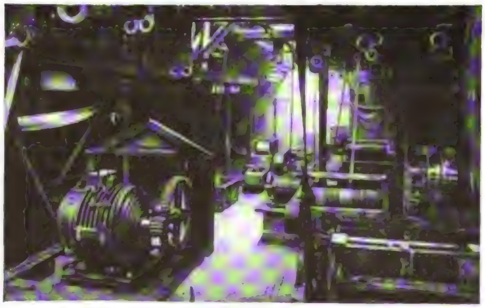


FIG. 3. THE BLEACH HOUSE.

FIG. 4. THE DYE HOUSE.

machines, of which there are seven of various sizes and appropriated to special uses such as white drying, black drying, and back finishing. The motors, which are of three sizes, viz., 9½h.p., 14½h.p., and 19h.p. respectively, are directly connected to the drying machines by spur gearing, and each one is provided with a variable speed controller for adjusting the speed at which the cloth may be passed over the steam-heated drying cylinders. The steam arising from the drying is exhausted from the room by a 54in. fan, driven by belt from a 6½h.p. motor.

The dye house is shown in Fig. 4, and here again the motors are all of the entirely enclosed type, and are fitted with speed-reducing back-gears. Most of the machines, such as squeezing machine, dunging machine, pump, and so forth have individual drives, but the dye becks and soaping becks are driven collectively in each case from an overhead shaft receiving its power from a motor of 17h.p. at one end. The power of the indi-

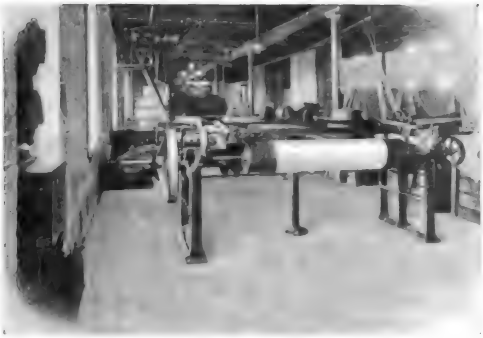


FIG. 5. STENTERING MACHINE.

FIG. 6. ONE OF THE CALENDERS.

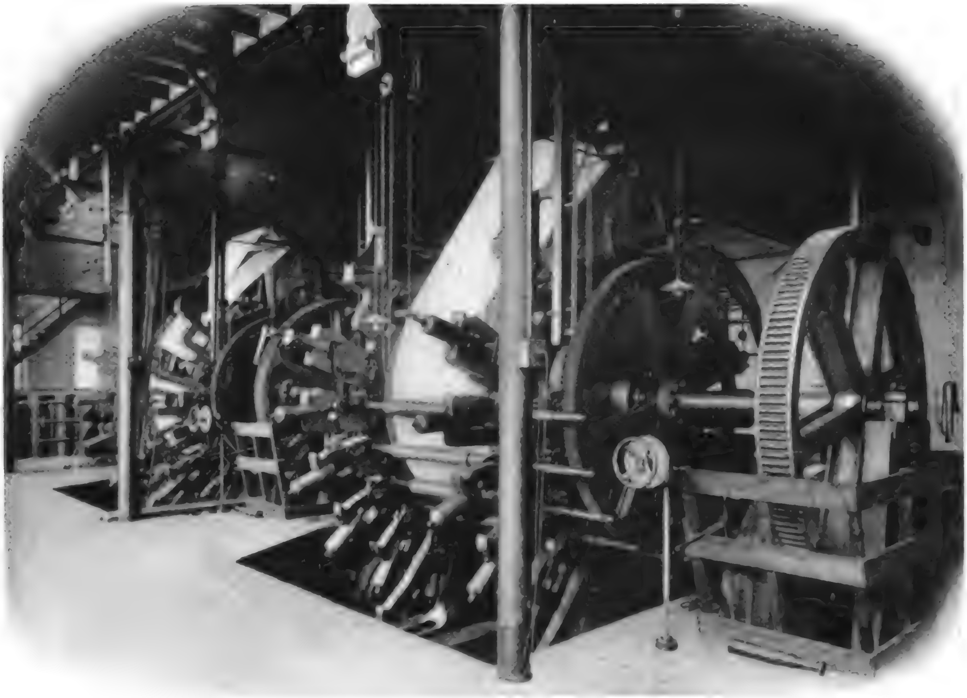


FIG. 7. THE INTERMITTENT PRINTING MACHINES.

vidual drive motors varies from 6½h.p. each to 11h.p. each.

The water for the dye house and other uses is furnished by one of Mather & Platt's patent turbine pumps with direct-coupled motor of 25h.p.; it is capable of delivering 600 gallons per minute. In the clay house the mixing pan is driven by belt from a compound wound motor of 9h.p.

The large 90ft. stentering machines, of which there are four, are each driven by belt from a 17h.p. motor. Each motor has a variable speed controller, while it can be instantaneously stopped by pressing a push-button placed at the delivery end. Below the frames of the stentering machines are the heaters, which are provided with air by means of four Sirocco fans, each driven by a direct-coupled 25h.p. motor. The heaters are especially powerful and it is possible to pass the cloth through the stenters at a speed of 90 yards per minute. Besides these large 90ft. stenters, there is also in another part of the works a 20ft. stenter without heaters; in this case the machine is belt-driven by a back-geared 5h.p. motor. A view of this installation is given in Fig. 5.

In the stentering house are also located the calenders, one of which is shown in Fig. 6 with its barrel-type electric controller. There are in all three calenders for glazing and finishing, in each instance the drive being by direct toothed-gearing; the motors are respectively of 18h.p., 25h.p., and 33h.p. The regulation of the speed whilst running is effected by varying a shunt resistance. Behind the calenders is a small electric hoist for lifting the batches to the floor above; this is driven by a 1½h.p. motor.

The ordinary printing machines are still driven by coupled steam engines at the present time, though they too are scheduled for conversion to electric power. There are, however, two large new machines specially designed for printing the many-coloured sarees beloved of Eastern women, and these are each driven by a direct-geared motor of 65h.p. In the accompanying illustration, Fig. 7, the motor driving the left-hand printing machine can be perceived dimly under the floor level through the pit in which the right-hand machine stands; the motor of this latter machine is, of course, not visible. These motors are of special construction, with double-wound armatures, and provided

with series-parallel controllers, so as to cope with the very wide range of running speeds required, which may be anything from ten yards up to sixty yards of cloth per minute passing through the printing machine. In proximity are small motors driving respectively a brush-washer and a polishing lathe.

A special department is devoted to the preparation of the copper rollers used in the printing machines. It has generally been customary to use solid copper shells, which are forced on to the mandrels, but in these works the more modern method of using cast-iron shells with electrolytically-deposited copper surfaces has been adopted with very great success. The plant used is shown in Fig. 8. The cast-iron cylinders are first cleaned by a sand blast, the air compressor being driven by a small electric motor, while an exhaust fan, also electrically driven, is fitted in the sand blast chamber to carry off the dirt and dust; the cylinders are then treated in a cyanide vat and afterwards transferred to the electrolytic vats shown. In order to obtain the requisite low-pressure current for the electro-deposition a small motor-generator set has been installed, the motor of which is rated at 32h.p. taking the 220-volt current, and the dynamo giving a current of 1600amp. at 8 volts. This latter machine is separately excited, its magnet terminals being connected to any two points on a resistance bridging the 220-volt supply mains, whilst the armature is singly wound and there is therefore only one commutator.

There are still a few scattered motors, viz., one of 5h.p. driving the steaming and ageing machine, a similar one driving the aniline ager, and one of 11h.p. in the mechanics' shop. Summing up the whole plant, there are twenty-three motors for outputs below 10h.p.; twenty-four for outputs between 10h.p. and 20h.p.; six motors of 25h.p.; two motors of 32h.p.; and two of 62h.p., making a total of fifty-seven motors, capable of giving over 800h.p. In addition to the power supply the works are also electrically lighted from the generators.

It may be of interest, especially to those engaged in the textile trades, to mention that a number of the machines referred to above as being driven by Mather & Platt electric motors have been manufactured by them. This dual experience, both of the bleaching, dyeing, printing, and finishing machines to be driven and of the electric motors to drive them, is probably possessed by no other manufacturers, and naturally makes for the entirely successful solution of the problems entering therein and the general perfection of the work done.

Fig. 8. The Electrolytic Plant.

SWITCHGEAR FOR TEXTILE FACTORIES.

J. G. STATTER, M.I.E.E.

THE switchgear for textile factories requires to be of a simple, inexpensive, but at the same time of a reliable nature.

In some textile industries, particularly spinning and weaving, it is necessary to have a fine speed regulation. In spinning the machines are run at as high a speed as possible short of breaking the thread. This requirement for a fine speed regulation indicates at once a d.c. current distribution throughout the factory, although if the power is taken from a power supply company the current delivered to the mill will initially be a.c. and must be converted by means of rotary transformers or motor generators.

Other textile industries may of course with advantage use static transformers for the first reduction in pressure and squirrel cage or slip-ring motors to supply the power where required.

It is however the purpose of this article to consider only the problem of textile switchgear as it relates to direct current.

The illustration Fig. 1 shows a suitable main switchboard for controlling the user's own plant. It will be seen that this switchboard is equipped with circuit-breakers, main switches, ampere-meters, and wattmeters, with paralleling and bus-bar voltmeters mounted on the top. The correct equipment of such a board is as follows:—

For the generators.—Each generator panel should be equipped with a maximum and reverse current circuit-breaker, the maximum movement having a time lag. Positive, negative, and equalizer switches, shunt regulator and shunt-breaking switch, amperemeter, and paralleling plug.

For each feeder the equipment should be maximum circuit-breakers with free handles and ampere-meters; wattmeters may be added on either generator or feeder panels. It is desirable to measure the output at one or other of these points. If the number of generators is limited to two or three, and the number of feeders is much greater, then it is more economical to measure the output in Board of Trade units at the generators, or alternatively, a main wattmeter inserted in the bus-bar may be employed, but this has the disadvantage that it is impossible to construct a wattmeter which will indicate with very small currents and at the same time carry very heavy ones.

The difficulty has in some cases been met by having two wattmeters with a change-over switch, but this depends too much upon the attendant, and is a bad arrangement. It is better to use individual wattmeters, either on the generator or on the feeder panels, as circumstances may indicate.

Bus-bar and paralleling voltmeters are necessary to complete the equipment.

The illustration of the switchboard shown was taken from a photograph before the expanded metal doors had been erected to close in the back of the switchboard. These should always be provided and fitted with latch locks which may be opened by hand from the inside so that the attendant may never be accidentally imprisoned behind the board. The type of shunt regulator shown in the switchboard illustrated is the pillar type placed in front of the board, but it is somewhat more economical to mount the shunt regulator on the switchboard itself.

It will be seen from the equipment given for generator and feeder panels that much less switchgear is recommended than is often adopted. It is a great mistake to overload a switchboard with a large number of inferior fittings, where a better effect could have been obtained by the use of fewer but more complete units of apparatus. For example, on the generator panel one circuit-breaker with a time lag on its maximum movement and having its reverse movement controlled by entirely separate mechanism, so that either maximum or reverse can be separately adjusted, is amply sufficient, and is a better arrangement than putting on two cheaper circuit-breakers, one on either pole.

Again, on the feeder panel, it is very common to provide a switch; if, however, a maximum circuit-breaker is a properly designed one with a free handle and a hand trip gear, the provision of a switch is useless reduplication, as the circuit-breaker can always be used for the purpose, and effects the breaking of the circuit in a far better manner than a switch, while if properly designed it is equally good for making circuit.

The Control of the Motors.

In spinning mills the usual method of driving electrically is to divide the machines up into groups, driven from a common shaft in such a way that motors of a reasonable size are required. For example, an ideal arrangement is to divide the machines up into groups requiring about 100h.p. per group. Any stopping of an individual machine that may be required is then carried out in the old and perfectly satisfactory way of throwing off the belt driving this particular machine. The rest of the machines run with a fairly constant load and at a fairly constant speed, but this speed is important; it must be adjustable, and when once correctly adjusted it must not vary.

There is no power more suitable for this purpose than electricity.

The essential switchgear for the control of each motor consists of a starter, a speed-regulator, and means for breaking the circuit instantly. There are several starters and speed - regulators on the market, but the standard article omits to provide a sufficiently fool-proof arrangement. The employment of a speed-regulator, which to be economical must be one which introduces resistance into the shunt circuit of the motor, brings in a difficulty. The attendant, although a reasonably careful man, may omit to return his speed-regulator to zero, and on starting up switch on the armature current with all the speed-regulating resistance in his shunt circuit. Under such conditions difficulty will be experienced in starting and the machines will accelerate slowly, so that time is lost. It is also bad for the motor and for the generating station. The motor has to start up against the load and may under such conditions absorb a sufficiently large current to burn out the coils of the starting switch or to bring out the circuit-breaker. The Switchgear Company provides a combined starter and regulator, in which, on the volts falling or the motor being stopped, the shunt resistance is automatically cut out and cannot again be inserted until the regulating handle has been brought down to zero. This type of switch is embodied in the panel shown in the illustration Fig. 2. This panel is the Switchgear Company's standard panel for textile work, or for any other work in which speed regulation is required. Used in combination

FIG. 1. TEXTILE SWITCHBOARD, PHOTOGRAPHED BEFORE FIXING THE EXPANDED METAL DOORS TO CLOSE IN THE BACK.

with an interpole motor, any desired regulation of speed within very wide limits may be obtained. The panel contains a maximum control provided with a Statter time lag and the shunt-regulator with Sugden's automatic short-circuiting device as above described. It is also provided with an ammeter, calibrated in horse-power or amperes, as may be desired. The illustration shown in thick lines shows the standard panel up to 50h.p. In this case the Statter time lag controlling the motor with no load magnet is in itself an efficient circuit-breaker. It will be noticed that one switch only is provided; this is amply sufficient. The time lag starter, which is a well-made, reliable article, is inserted in one line; the switch, which is equally well made and of ample proportions, is inserted in the other. When the switch is opened the starter lever automatically breaks the circuit so that the circuit is broken on

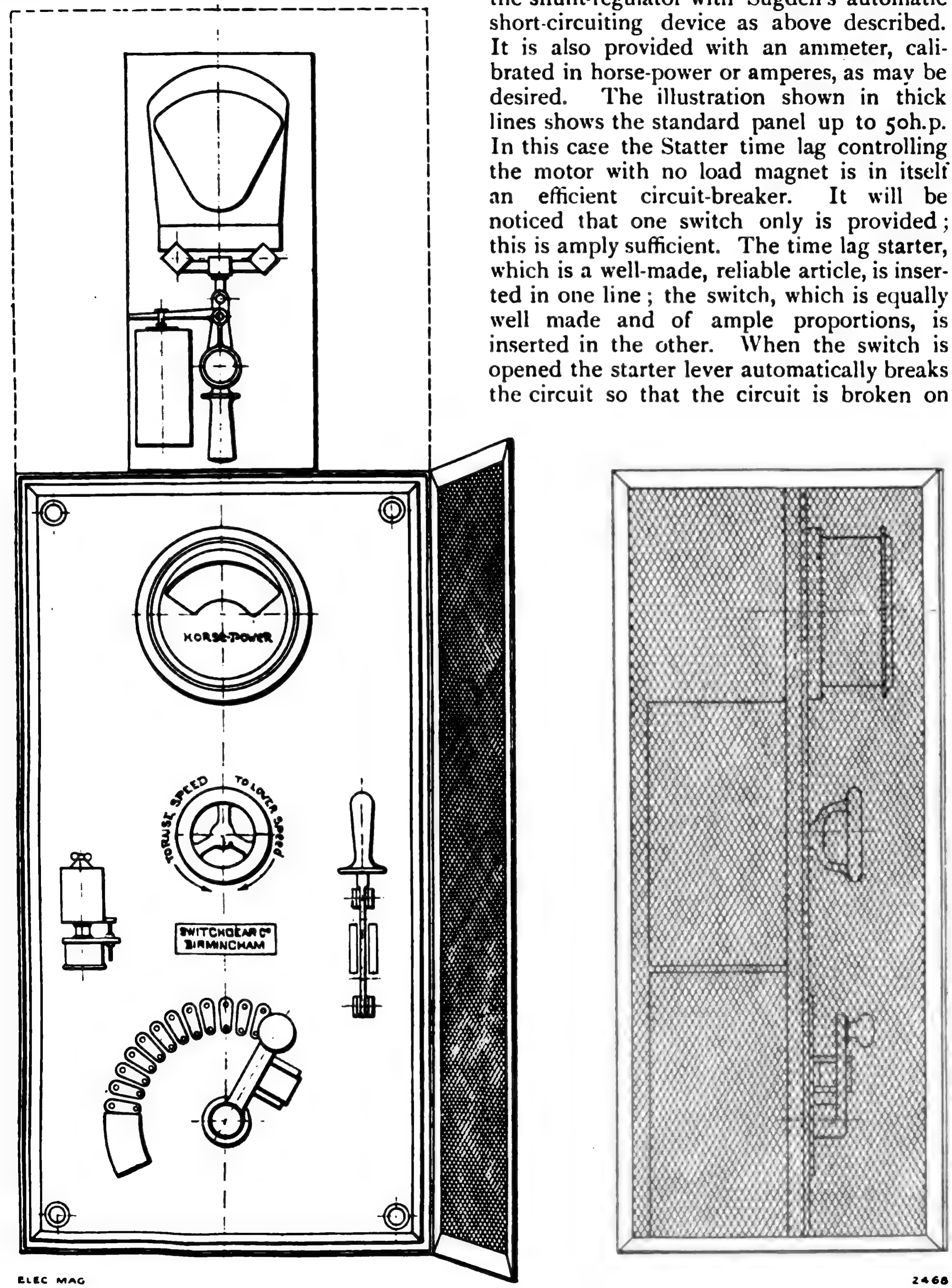


FIG. 2. STANDARD MOTOR SWITCHBOARD PANEL, AS MADE BY THE SWITCHGEAR COMPANY FOR TEXTILE WORK OR FOR VARIABLE-SPEED MOTORS IN GENERAL.

both poles and the motor may be handled with impunity.

For large currents as required by motors of 50h.p. and upwards, a compact circuit-breaker is added to the equipment and the time lag is applied at this point. The starter then becomes a simple no-volt appliance, and the circuit-breaker is in series with the starter, so that one line is broken by the circuit-breaker or starter, and the other by the switch. The opening of the switch automatically causes the other pole to be broken by the no-load magnet of the starter releasing the starting switch arm and the circuit-breaker remains closed.

To those who are not familiar with the Statter patent time lag a few words as to its operations may be added :—

This instrument protects the motor fully under all conditions of overload, but will allow it to be run near to, but safely within the danger point. This means that with a well-designed motor you may at times be working it at 50 per cent. or 60 per cent. above its rated output. In present practice this is frequently done, and a foreman finding that the motor stands 50 or 60 per cent. overload while he is looking at it assumes that it will stand it permanently, with the result that the motor breaks down and the user has not only interruption of his work, but also a repairs bill to pay. The time lag will allow it to bear the overload as long as it is able to do so. A 50 or 60 per cent. overload would only be kept on for a few minutes, whereas a 20 per cent. overload would be allowed to remain on much longer. On the other hand, a load of twice the normal would be switched off in a matter of a minute or so.

These figures are simply indicative of what can be done with the apparatus. Each case has of course to be treated on its merits and the appliance adjusted to suit the capacity of the motor. This however can be done once and for all by an expert and the apparatus then locked.

For those who have starters already in use the Switchgear Company supply a relay form of the time lag appliance, which gives all its advantages.

The relay is enclosed in a lock-up box, and the required connections are all electrical, so that the apparatus can be fixed and connected complete by a wireman in a very short time. This useful and ingenious appliance will save its cost more than once every year.

THE TRANSMISSION AND APPLICATION OF ELECTRIC POWER IN SPINNING MILLS.

W. ALLAN FIELD.

(*The Author of this Article is an expert mechanical engineer and machine designer who has had very considerable British and Continental experience of the subject on which he writes.*—ED. E.M.)

It is not intended in this article to deal with the comparative advantages of electric as against mechanical driving in textile mills. Much has been said by the numerous advocates of electric power pointing out by substantial arguments, reliable figures, and the actual data and facts of practical experience the economies to be effected by the adoption of the electric system in textile manufacturing.

In most cases the new mills have been specially constructed for the installation of electric power, but there are also many examples of mills which have been converted and provided with generating plant, or which are being supplied with electrical energy from local power supply companies' mains.

No doubt the numerous factories which have been or are being fitted with this form of drive will ultimately demonstrate and prove once and for all that the old-time steam and mechanical transmissions must give way to electricity.

The application of the electric drive to spinning mills has raised many controversial points, and it is the purpose of this article to review the various systems in vogue and to weigh the advantages of the different methods, each on its own merits.

Commencing with the item of main generating plant, which, compared with mechanical driving, involves practically a dead extra on initial cost of a new mill, raises the question of outside supply of energy. In cases where financial conditions render the cost of a private generating plant prohibitive, or, where floor space is restricted, the argument for the local power company's supply appeals very strongly: since the elimination of the cost of a main generating plant means the saving of a considerable amount of capital which could be sunk in additional productive machinery or otherwise invested. The increase of profits thus obtained permits of the payment of the higher price of power obtained from power-distributing stations.

Take for example a mill of 100,000 spindles: by striking out the main electric generating plant, something like £10,000 would be spared. This sum could be devoted to the laying down of other 7500 spindles, increasing the output of the mill by 7½ per cent. on the original capital. Taking establishment charges at 12 per cent. of the manufacturing costs, this increase in output would reduce manufacturing costs by about 0.9 per cent., standing charges remaining the same. These figures are given with apologies to those already familiar with the far-reaching effects on profits of increased production. With regard to the sub-division of power and its application in the mill, there are many points to be taken into consideration in order that the economies that the electric system undoubtedly affords may be utilised to the greatest advantage.

"Individual" *versus* "group" driving is still a somewhat controversial point, and although the steady nature of the load and speed of most of the machines used in cotton spinning render them particularly suitable for the direct drive, general opinion seems to be divided in the matter.

The main points to be taken into consideration when comparing the two systems are as follow:—

Group Drive.

1. Use of large motor and consequent reduction of first cost of motors per horse-power.

2. Higher full-load efficiency per motor and consequent minimum of *electrical* losses between switchboard and machine.

Direct Drive.

1. Elimination of belt drives and shafting with consequent saving in horse-power on friction load, or, in other words, minimum *mechanical* losses between motors and machines.

2. Improved quality of production, and also increased production due to the positive nature of the drive.

Here again in this discussion manufacturers are apt to tie their argument down to the subject of first cost, regardless of what

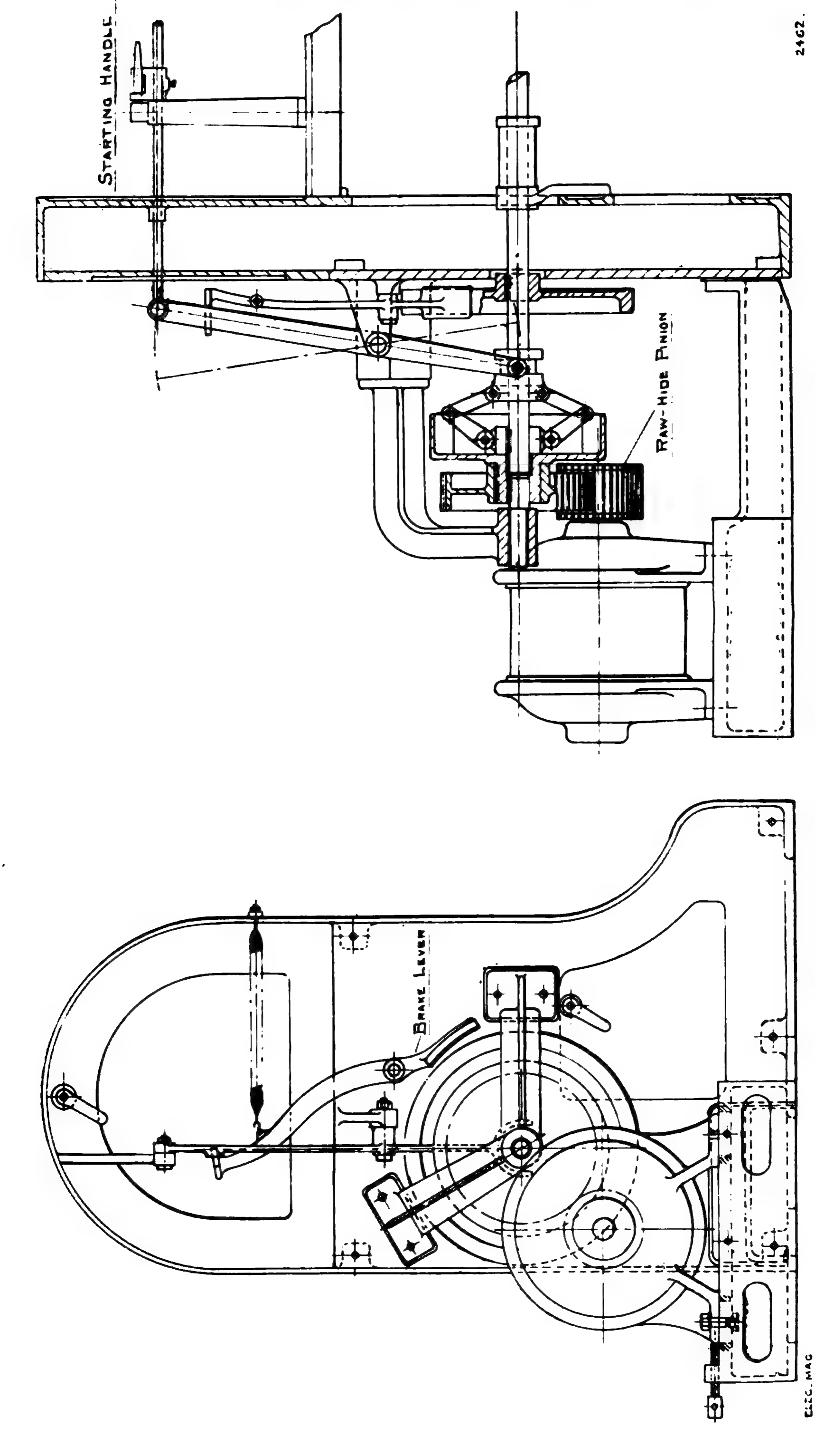


Fig. 1. Mechanical Arrangement of Independent Motor Drive for Speed Frame

might be the ultimate and greater savings and economies effected by the adoption of the direct method of driving.

By way of demonstrating the saving which can be effected in some cases by direct driving, a few figures will be taken.

Take, for example, 60 fly frames, each absorbing, say, 4h.p., which would agree with average practice. For group driving a length of shafting about 330ft. to 350ft. would be required. The friction load at the lowest estimate for the shafting alone would be 50h.p.

The first cost of installation of the group drive in this case would average :

One motor, &c. (300h.p.)	£500
Belts and shafting ...	£150
Total	£650

Whilst the first cost of installation of the direct drive would be

60 motors, &c. (4h.p. each) = £1200

The balance in favour of the group drive is thus £550, the interest on which at 5 per cent. per annum would amount to £27 10s.

Now the power absorbed by the group drive, taking the efficiency of motor at 90 per cent.

$$\frac{240 + \text{shafting load}}{0.9} = 322.2\text{h.p.}$$

as against the power absorbed by the direct drive taking efficiency of the motors at 80 per cent. on full load

$$= \frac{240}{.8} = 300\text{h.p.}$$

This shows a saving of 22.2h.p. in power by the adoption of the direct method.

Assuming the cost per horse power annum at £5 gives an annual saving of about £111 as against the £27 10s. interest on the capital cost difference of the two methods. The result is therefore a margin of £83 10s. per annum in running costs for the direct drive, which at this rate would pay for the added investment occasioned by the direct drive in seven years.

The writer does not claim that this proves the individual drive applicable to all cases ; each case should receive careful consideration on its own merits as to whether the one system or the other is more suitable for the requirements. It is possible in some cases for the capital necessary for direct drive to assume prohibitive proportions, in which event it might be invested so as to afford greater advantages to a company than it would as dead capital sunk in power plant.

The Group System.

With the group system of driving the motor is frequently coupled directly to the line shaft. This can only be done economically when the speed of the shaft is fairly high. The primary reason for the high speed of motor is that makers desire to keep down the cost by having a motor of small dimensions.

Should the speed of the line-shaft be low, it is obvious that with standard motors some form of mechanical reduction gear between the motor and the line-shaft is necessary.

The popular methods of gearing are :—

1. Belting.
2. Rope driving.
3. Silent chain belting.
4. Spur gearing.

Belt Driving.—The belt method is still extremely popular, and gives almost any desired ratio of speed simply and conveniently. It is cheap and applicable to almost any case where space is sufficient.

Rope Driving.—This form of drive works out at roughly the same cost as by leather belting when the extra cost of the grooved pulleys is taken into account. It is noiseless, can be used to transmit power over greater distances than any other form of mechanical gearing, and works with the greatest efficiency at a rope speed of about 4800ft. per minute In practice the minimum diameter of rope pulley is fixed at thirty times the diameter of the rope used, and should a large reduction of speed be required the diameter of the driven pulley is apt to assume large proportions. This often necessitates a complication of countershafts, in which case a more positive form of connection is to be preferred, which can best be obtained by using chain gearing.

Silent Chain Gearing.—This type of gearing, besides being particularly advantageous in giving a flexible reduction gear of high ratio with minimum wheel diameters, is especially applicable when the distance between the shaft centres is too short for belt or rope driving and too great for spur gearing. Messrs. Hans Renold claim the credit for the development of this form of driving in this country. The chain wheel teeth resemble closely the ordinary form of spur wheel teeth.

The silent Renold chain operates successfully at speeds as high as 1800ft. per minute.

The driven wheel should always be flanged, and the efficiency of the drive is 98 per cent. at 1200ft. to 1800ft. per minute.

Spur Gearing.—Should this form of drive be adopted the wheels are, of course, machine cut.

The noise incident to high-speed gearing has developed the use of the raw hide pinion, which runs well at a pitch line speed of 2000ft. per minute.

The application of the electric drive in the mill proper will now be considered, taking in order the various machines used in cotton spinning.

Mixing and Blowing.

The machines used in this portion of the mill, including bale-openers, automatic feeders, Crighton openers, scutchers, &c., could be readily arranged for the individual drive; the speeds of driving shafts being fairly high and therefore suitable for standard speed motors.

With the Crighton opener and combined opener and scutcher, the only necessary modification in the design of the machine would be a slight alteration of the bracket supporting the driven end of the self-contained countershaft, with which these machines are usually supplied. The said bracket would need to be arranged to carry the motor, geared with spur wheel and pinion to the countershaft, which runs at about 500 to 600r.p.m., the power required being about 8h.p. for double or combined machines and 4h.p. single machines.

With the remainder of this portion of the plant, the only modification would be the preparation of a housing on the body frame of the machine to carry the motor with reduction gear as required.

If the group system is adopted in this department, a shut-down, say in case of accident to the single motor driving the line shaft, would result in a temporary stoppage of the rest of the mill, and, for this reason alone, the better method appears to be that of the individual drive, where the trouble would be confined to one particular machine.

Again, this part of the plant forms but a small portion of the machines required for a mill of a given output, and, in view of the above-mentioned advantage, the first cost of the larger number of small motors is well worth considering.

Cards.

The revolving flat carding engine requires ¾h.p., or about 8h.p. for ten machines, with a pulley speed 160r.p.m. to 170r.p.m. according to circumstances.

With these machines, the motor may be connected to the line-shaft either at the end or in the middle, by belting or spur gearing, in order to obtain the necessary reduction

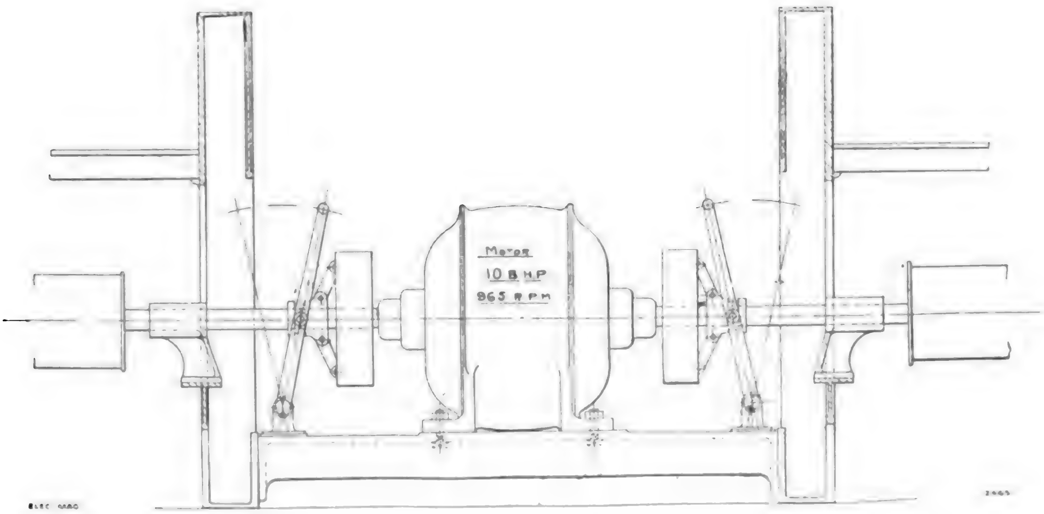


Fig. 2. Mechanical Arrangement of Drive for Two Ring Frames by Motor Coupled Direct.

which the low speed of driving shaft calls for: they can be conveniently arranged in groups depending on the size and shape of the room; an allowance of 15 to 20 per cent. of power transmitted being made to cover friction load of shafting in deciding the capacity of motor required.

Speed Frames.

The usual length of roving frame carries 180 to 200 spindles; the power required working out at 2h.p. for every 140 spindles.

These machines may be arranged either for the group or independent drive; the speed of driving shaft being 300 to 450r.p.m. according to the class of work.

The group drive may be arranged with the motor geared to the line-shaft or coupled direct to it.

With the latter arrangement using induction motors of the three-phase type arranged in units of 150h.p. to drive, say, 35 frames, each motor would require about 200ft. of shafting and should be located at the middle of its length in order to reduce the resultant twist at the ends of the shaft. With this arrangement at 600r.p.m. (the standard speed for a motor of the type mentioned), the diameter of shaft required is considerably less, for a given power transmitted, and gives a large saving in shafting cost.

This speed of line-shaft, which is uncommon in this country, is perfectly practicable with a peripheral speed of shaft not exceeding 400ft. per minute; ordinary commercial bearings, about three diameters long, work efficiently and well with ordinary methods of lubrication at this speed, and with the size of shaft required it is well within these limits.

Again this subdivision of driving affords the independent operation of each of the various sections of the room, and, should an accident occur to any one of the motors, only that particular section is affected.

Coupling direct of motors to line-shaft necessitates some form of coupling between the ends of the rotor-shaft and the line-shaft, which may be either rigid or flexible. Since it is somewhat difficult to adjust several bearings in exact alignment, and from consideration of the difficulties which might arise should any of the bearings wear more than others, or owing to "settling" of the building, a flexible coupling is to be preferred.

A simple form of coupling may be devised by using ordinary three-jaw couplings with

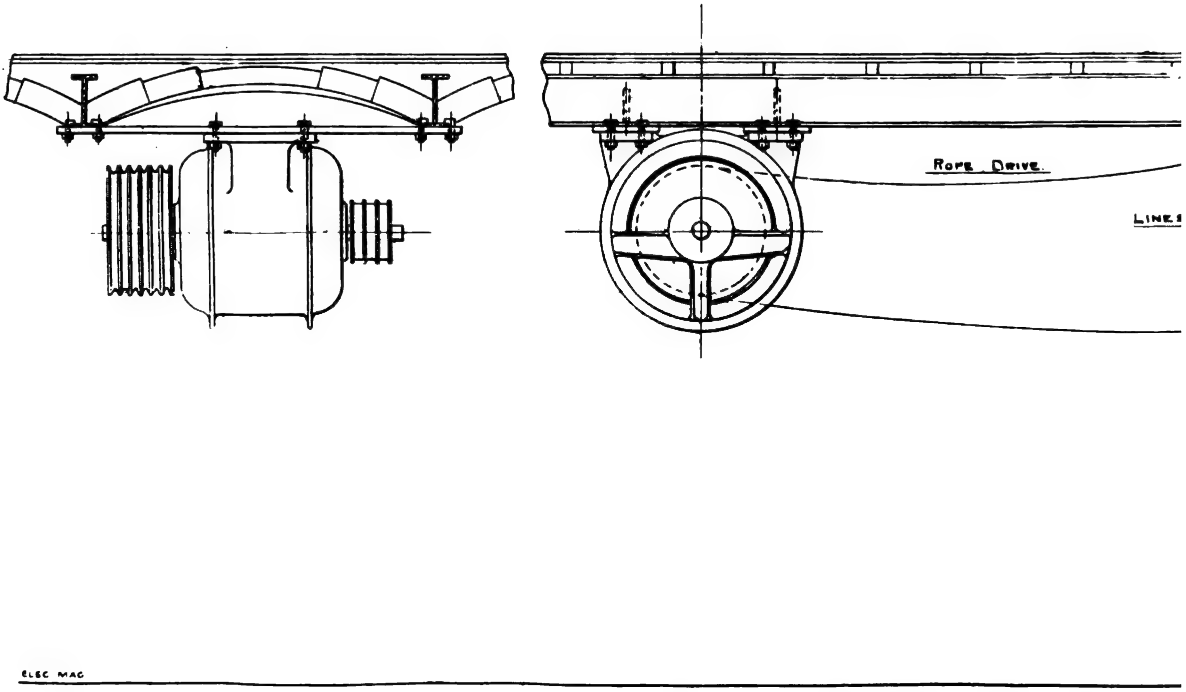


Fig. 3. Mechanical Arrangement of G

rubber washers screwed to the sides of the jaws of one half of the coupling.

Fig. 1 shows an arrangement of independent drive for speed frames with the necessary modifications of existing models.

The friction clutch is introduced as a ready means of stopping and starting the frame; such stoppages being frequent on this machine for piecing-up or doffing.

The existing brake lever is required as a means of braking the momentum of rotating parts in order to bring the machine rapidly to a standstill; this lever is tripped by the forked clutch lever, being thrown off the brake pulley when the friction clutch is thrown in, and *vice versa*. The motor base-plate is bolted to the gearing end cover and is arranged so as to permit of ready access to the loose panel, and the change gearing enclosed in the frame end; the driving shaft is connected to the motor by means of spur gear and raw-hide pinion.

Ring Frames.

With ring spinning frames, even in England the question of first cost is waived, and in nearly all cases the individual drive adopted, the reason being apparently the better quality of production obtained, due to the more constant speed maintained with this form of drive.

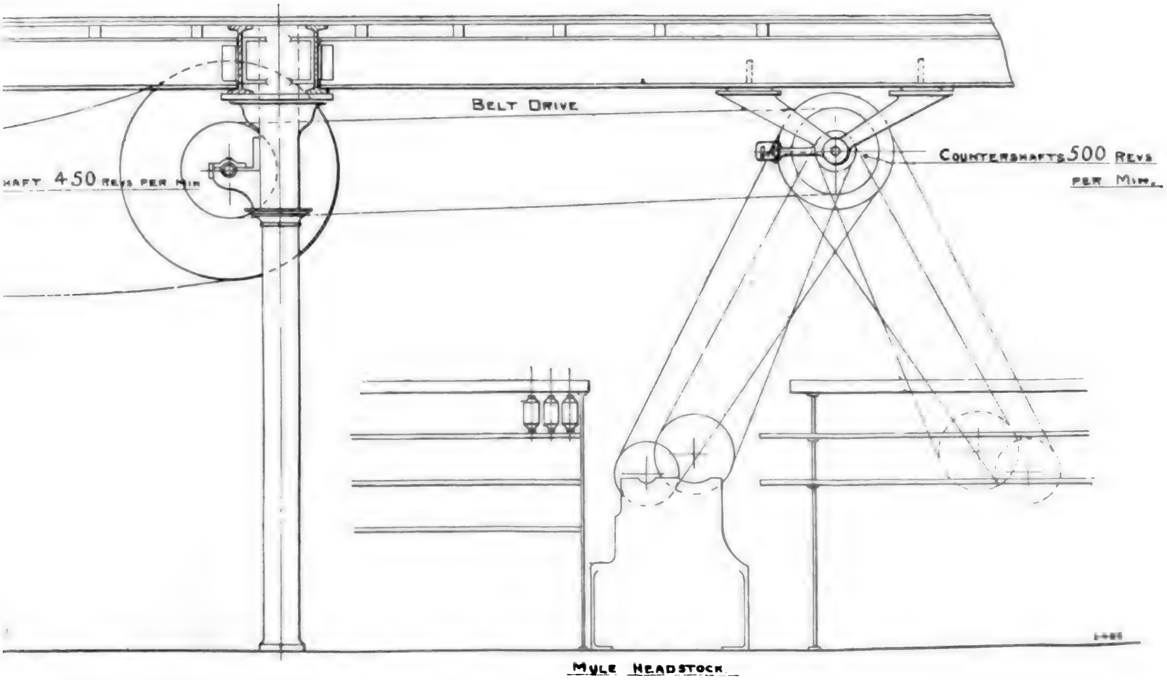
The usual length of these machines is 45ft. to 50ft., carrying 400 to 450 spindles; the power required working out at about 90 spindles per horse-power with a driving shaft speed 800 to 900r.p.m.

Fig. 2 shows an arrangement of one motor of 10h.p. driving two machines, the motor being coupled direct to the tin roller shafts.

This arrangement necessitates the use of friction clutches, to render the frames capable of independent operation.

Fig. 4 shows an arrangement of drive with the machines placed end to end; two motors are placed in between, each driving one frame through spur gearing. With ring frames, piecing up can be effected whilst the machine is in motion; hence the independent friction clutch starting device, as necessary on speed frames, is not here required.

The starter resistance is placed on a bracket bolted to the gearing ends at the front of the frame.



ꞁROUP DRIVE FOR SELF-ACTING MULES.

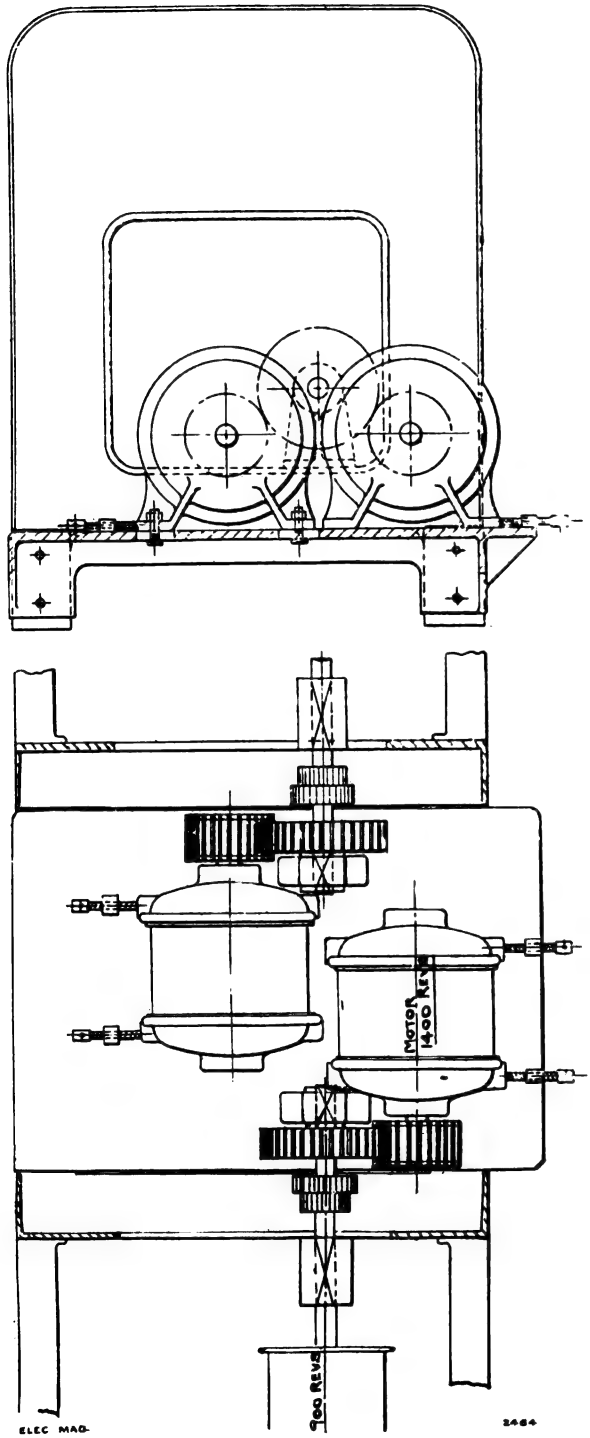


FIG. 4. ARRANGEMENT OF INDIVIDUAL DRIVE FOR RING SPINNING FRAMES.

Self-Acting Mules.

In general practice the group system is resorted to in mule driving, owing to the excessive variation in the driving load. The extent of this variation of power at the various points of the mule carriage cycle is clearly demonstrated by the plotted curve, a record computed from wattmeter readings; at the commencement of the outward run, the spindles, rollers, and carriage are started from rest and accelerated to their normal speed practically at the instant, and the large moment of inertia offered by the carriage mass and rotative parts calls for the excess of energy denoted in the diagram.

It is obvious, owing to this variation in demand of energy from the machine, that to apply the individual drive would necessitate the use of a motor of a capacity much greater than that required for the normal load.

It would appear that a carefully designed flywheel might overcome this difficulty, but investigation shows that a wheel arranged to cover the exact requirements between the limiting fluctuations of speed permissible with the commercial motor, would assume such proportions as to render its use undesirable; though something of the nature of a compromise might be effected.

The practice is therefore to drive a number of mules from a single motor, and if a reasonably constant speed of motor is to be maintained, it cannot be said to be good practice to group fewer than six pairs of mules.

The usual length of the self-acting mule is about 130ft., and carries some 1350 spindles of a weft gauge. Power is reckoned at 100 to 120 spindles per horse-power with a pulley speed of about 800r.p.m. according to circumstances.

In fixing the capacity of motor the horse-power per mule may be taken at ten to twelve horse-power, to which the power required for shafting load, taken at 15 to 20 per cent., should be added; each

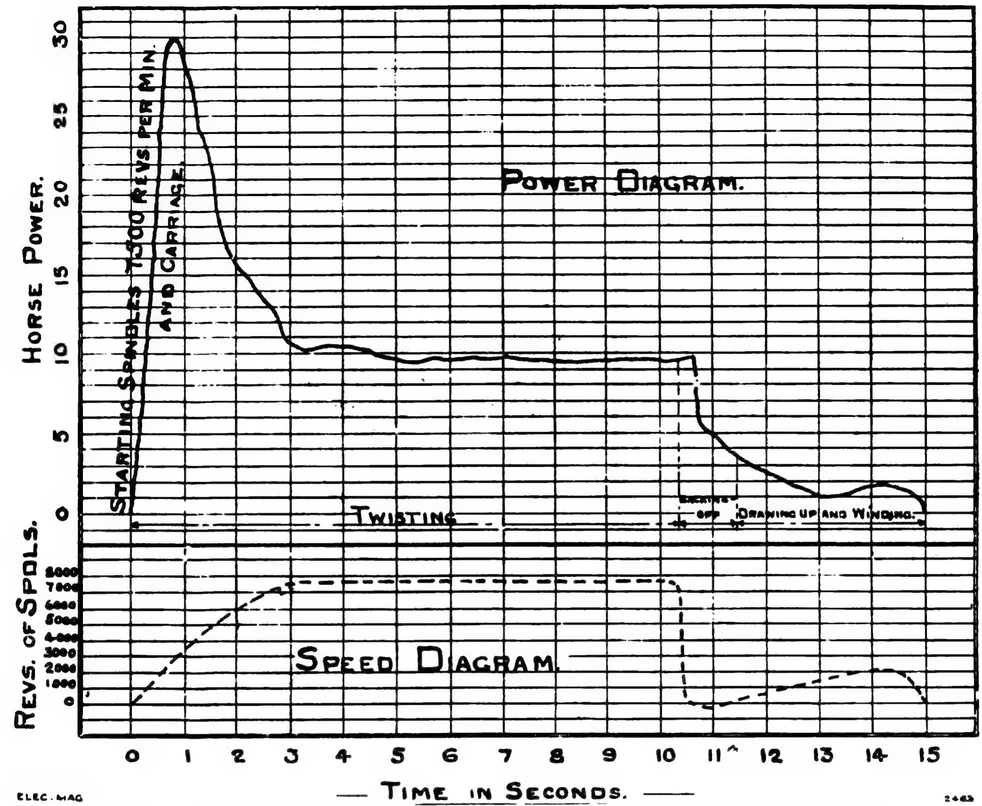


Fig. 5. Curve Showing Power Variation in One Complete Draw of Self-acting Mule.

pair of mules requires about 22ft. of shafting.

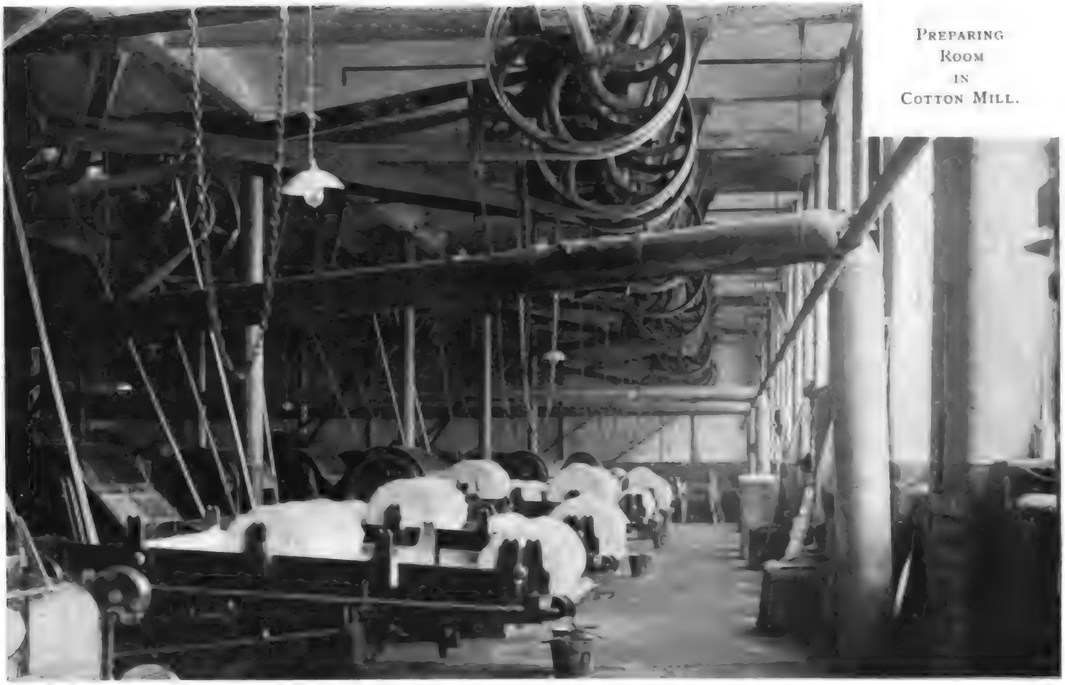
Thus mules can be driven in groups of six pairs with units of 150h.p.

Even with this arrangement variations in load of about 40 per cent. of the total average load are likely to occur, and it is obvious that the greater the number of grouped machines, the steadier the load will be, since the chances of several machines ever running in unison are thereby lessened: resulting in a smoothing over of fluctuations and offering something of the nature of a steady load for the motor driving the group.

The mechanical arrangement of group drive for self-acting mules, with the motor suspended from the ceiling, is shown in Fig. 3.

In conclusion it may be said that, with the constant load on power plant in cotton mills, the advantages accruing from the adoption of the electric drive in this class of work are naturally greater than those obtained in engineering workshops, where the load is constantly varying.

And in view of the satisfactory results obtained by its application in other industries, it might be safely predicted that in the very near future the electrically driven mill will be the rule and not the exception, whilst textile machinists will be called upon to furnish most of their machines arranged for the motor drive.



Preparing Room in Cotton Mill.

Carding Engines in Cotton Mill

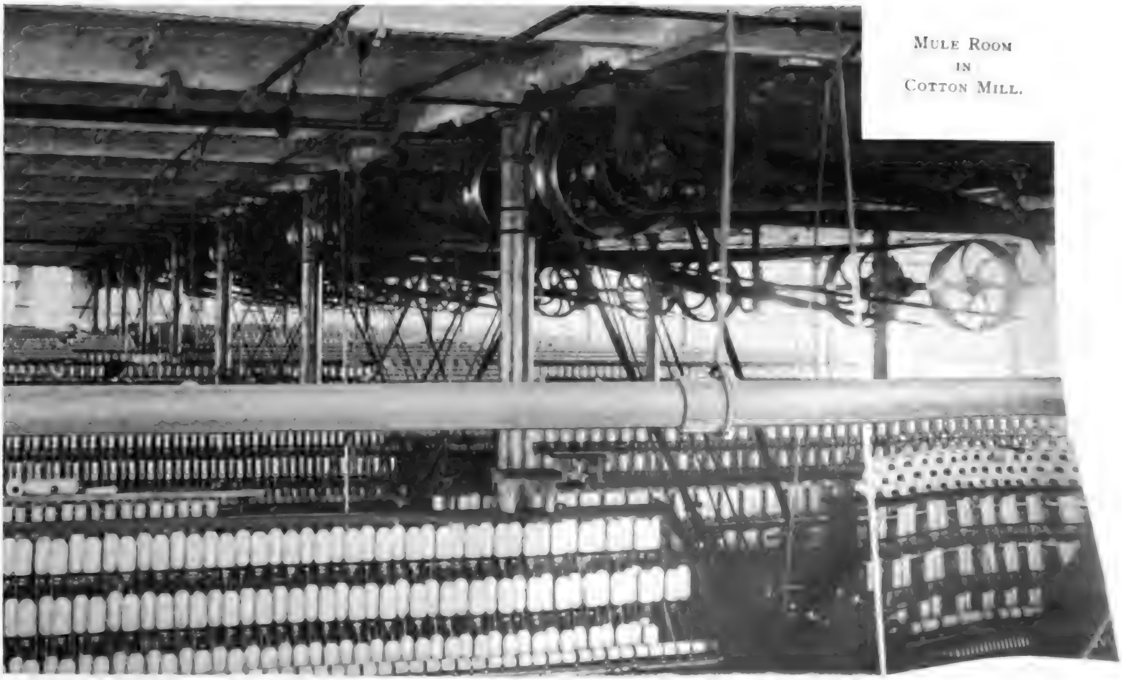
Figs. 1 and 2. Showing the Millwrights' Work in the Preparing Room and Card Room, respectively, of a 90,000 Spindle Lancashire Cotton Mill.

MILLWRIGHTS' WORK.

In this article some particulars are given of modern work done in the perfection of the mechanical arrangement of drives for textile machines. The use of electric motors dispenses to a greater or less extent—according to the mill department, nature of drive selected, and subdivision of the motor power, *i.e.*, group or independent driving—with line-shafts, pulleys, and belting; at the same time it is necessary that certain adaptations in the mechanical connections between motor and machine should be made to secure the maximum advantages of the electric drive. It is in this work that the up-to-date millwright finds ample and profitable scope for his enterprise and ingenuity. The several drawings and photographs reproduced show at once the degree of skill which has been brought to bear upon these mechanical transmission and regulation problems. They illustrate typical examples of work recently carried out by Messrs. David Bridge & Co., of Castleton, Manchester, a firm known throughout the country as one of the most important and progressive engaged in the engineering equipment of factories.

The illustrations, Figs. 1, 2, and 3, show the mechanical drives and transmission gear recently installed in one of the newly erected Lancashire cotton mills. This spinning mill has a capacity of 90,000 spindles; the preparing room, card room, and the mules, are shown respectively in the illustrations.

Illustration Fig. 4 shows a sectional drive for a weaving shed. This arrangement enables the manufacturer to disconnect one portion of his mill from the other instantaneously at any convenient time by means of the Heywood and Bridge's improved patent friction clutch, arranged as a shaft frictional coupling. A noteworthy installation of a similar description is one in which the total driving power of the cotton mill is transmitted through a similar friction clutch, which is equal to a capacity of 400h.p. In this case the main engine of the "Diesel" oil type is got up to full speed,



MULE ROOM IN COTTON MILL.

FIG 3. SHOWING THE MILLWRIGHTS' WORK FOR MULE DRIVING IN A 90,000 SPINDLE LANCASHIRE COTTON MILL.

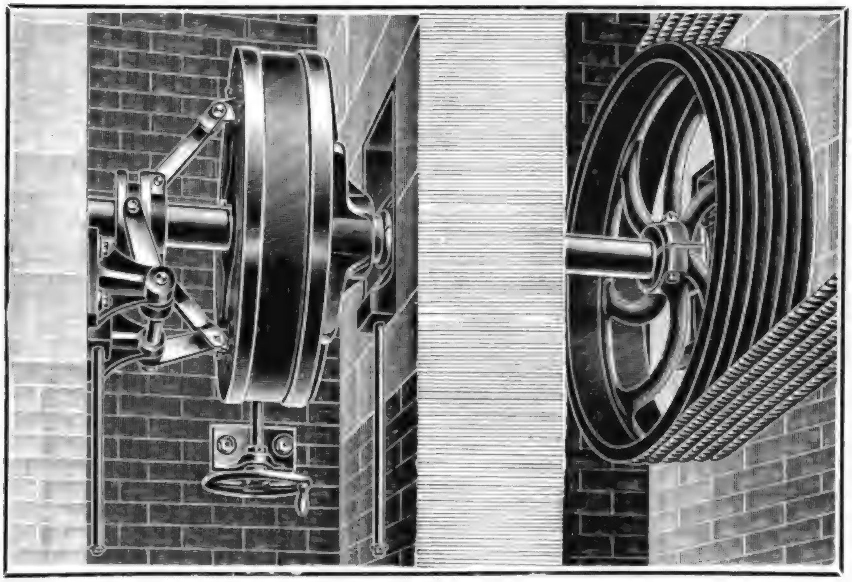


Fig. 4. Clutch Connection in Line-shaft for Sectional Driving of Weaving Shed.

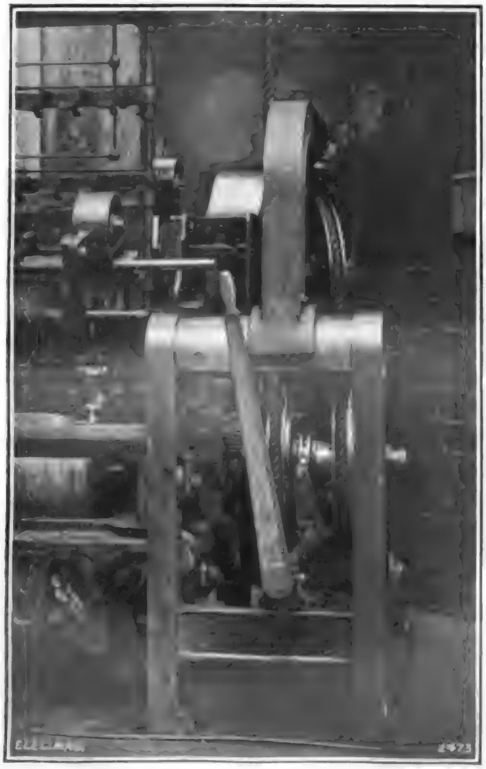


Fig. 5.

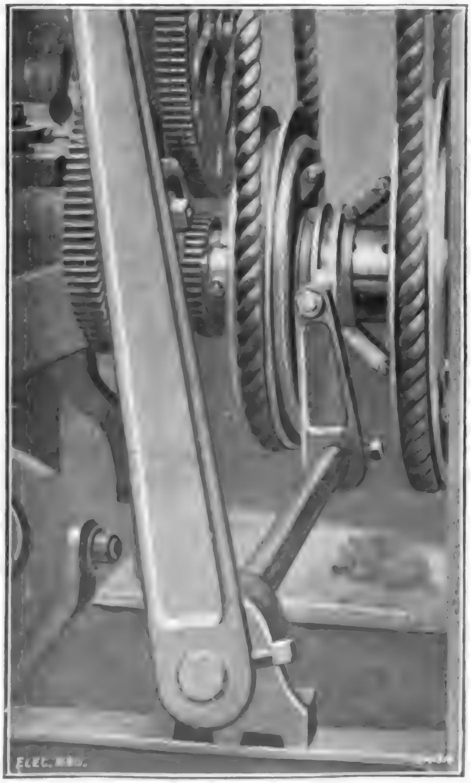
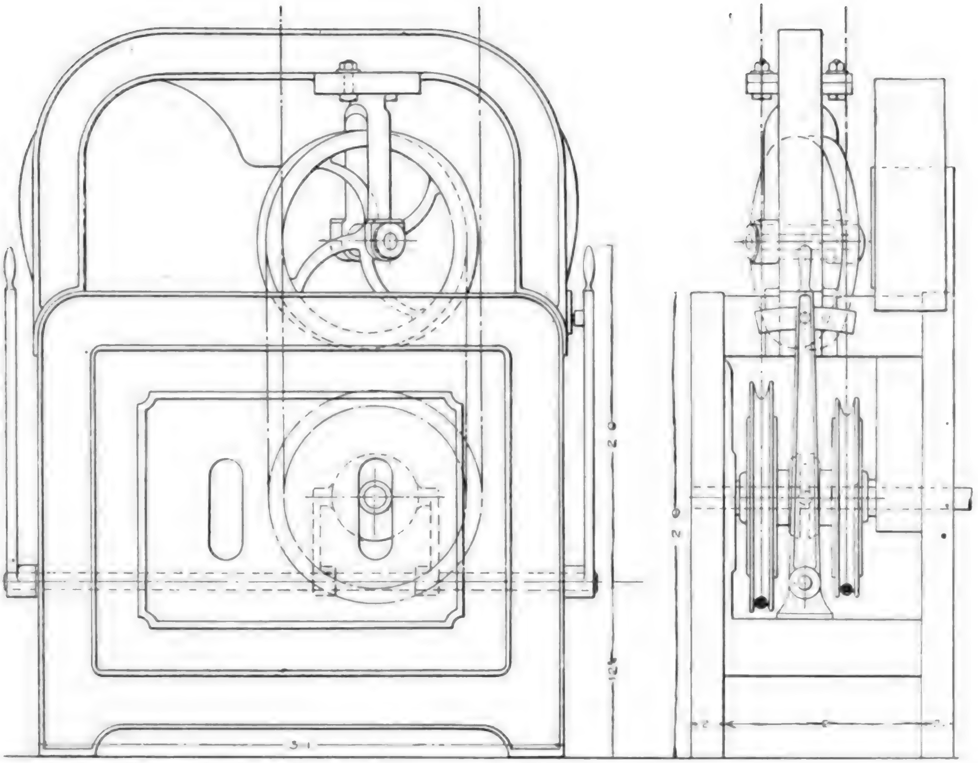


Fig. 6.

Views showing Heywood & Bridge's Friction Clutches coupled direct on the Tin Roller Shaft of Ring Frames.



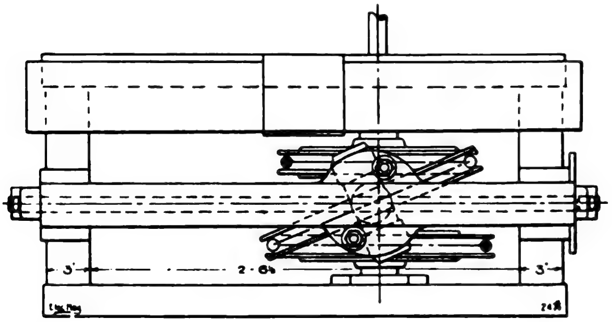


FIG. 7. SHOWING THE GENERAL ARRANGEMENT OF TWO-SPEED DRIVE FOR RING FRAMES THROUGH HEYWOOD AND BRIDGE'S FRICTION CLUTCHES.

then the clutch is put in gear, and it gradually takes up the load throughout the whole mill without any shock or jar taking place. The driven pulley is mounted on a mild steel hollow sleeve connected to the shell of the friction clutch. This sleeve is held in position by two bearings, independently of the shaft bearings; thus the weight of the driven rope pulley and the pull of the ropes is taken off the line-shaft altogether. Many of these installations are in use in connection with both gas and oil engines, some of which are giving out power up to 1000h.p. Figs. 5 and 6 are views showing two of the special type of Heywood and Bridge's friction clutches as fixed direct on the tin roller shaft of ring frames. The novelty of this arrangement is that it is a rope drive, and, as will be noticed, the pulleys secured to the clutches are of two different sizes. This enables the ring frame to be run at two independent speeds. The ring frame when it is necessary to build up a cop runs at the lower speed or a speed equal to

the high speed now run in connection with ring frames; shortly after starting the clutch is instantaneously switched over from the lower speed to the higher speed, which gives an increased output of about ten per cent. This is a very important invention for driving cotton machinery, and it should be noted that in practice it is giving entire satisfaction. In connection with this form of drive the line drawing, Fig. 7, shows the detail of the application of the clutches.

The other line drawing, Fig. 8, shows the construction of the small clutches, which are finding considerable adoption as connecting links between electric motors and ring frames, and for the electric driving of cotton machinery generally. At the present moment the makers are fitting up a cotton mill in Lancashire, in which their clutches of this type are arranged in this manner; that is to say, each ring frame is being driven independently by an electric motor. There are in all three electrically-driven cotton mills in this country now being equipped by Messrs. Bridge & Co.; they have also work of a similar nature in hand for abroad.

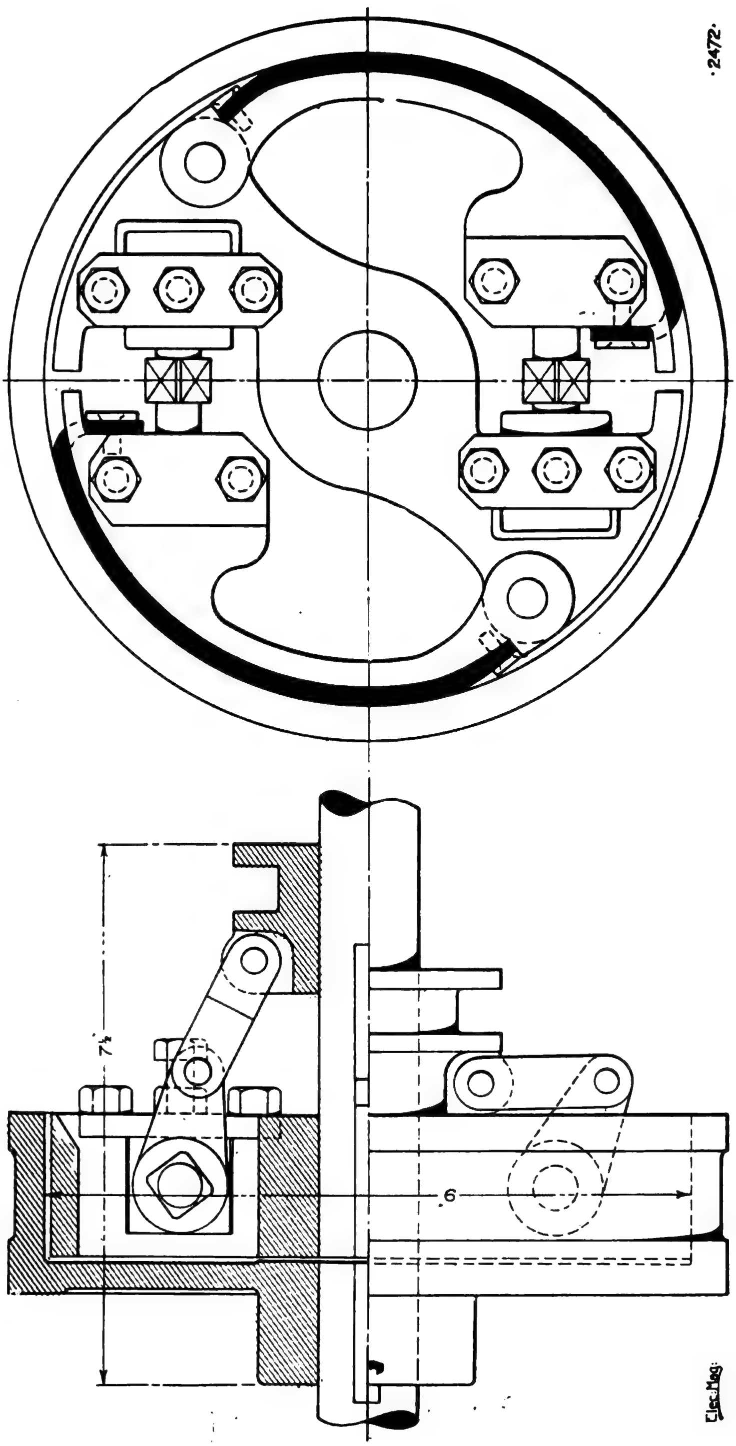


Fig. 8. Details of the Heywood and Bridge Small Type Friction Clutch.

PRINCIPLES OF EQUIPMENT AND A TYPICAL INSTALLATION.

F. WATSON JOLL, A.M.I.E.E.

ELECTRICITY has long ago been adopted as motive power in Continental cotton mills, but in this country it has been somewhat difficult to convince cotton spinners of the advantages which lie in electric driving by modern equipment. Up to a comparatively late date when cotton spinners have been approached by engineers on this subject the argument has generally been forthcoming that electricity may perhaps be used with advantage in the case of old and badly equipped mills, but that, given a mill laid out on the most modern lines, the system of direct rope drive from the main engine to the various lines of shafting cannot very well be improved upon. To a certain extent this might be correct if one considers only the actual cost in coal per h.p. transmitted to the machinery, but it must be borne in mind that there are many direct and indirect advantages to be gained by electrical driving which are too easily lost sight of when comparisons are being made. It is not only a question of the actual coal consumption, but of the total cost of producing the yarn, including coal, oil, labour, all losses in transmission, depreciation, and maintenance, and it is in these various factors, which make up the total cost of production, that a considerable saving can be made by the use of electricity.

In the most modern mechanically driven mill the whole of the shafting and gearing is driven by one engine, and it is most unusual for provisions to be made for stopping any individual shaft whilst the other shafts are running. Consequently, if any section of the machinery is not actually in commission practically the full transmission losses in ropes, shafting, belting, gearing, &c., are still incurred, and as these cannot be less than 25 per cent. to 30 per cent. of the power generated, this point forms an important factor for consideration.

On the other hand, with an electrical system of drive every individual shaft or, in the case of individual driving being adopted, every machine, is entirely independent of its neighbour, and any section of the plant can be run or shut down in accordance with the requirements for the time being, and when this is done the power generated is almost directly proportional to the power actually required by the machinery doing useful work.

Further, in the case of a new mill, when it is desirable, owing to the conditions of business or shortness of capital, to put down initially only a small amount of machinery, an electrical system of drive has a great advantage over a mechanical system, in that instead of putting down a large engine capable of meeting the ultimate requirements, as would probably be necessary with a mechanical drive, one generating unit can be installed capable of meeting the initial requirements, the units being multiplied as the capacity of the mill is increased, each extension which is made from time to time being arranged to work in parallel with the original installation without in any way disturbing the plant which may already exist.

An additional advantage in electrical driving is that every machine can be placed in a position most convenient to the system of working applying to each particular mill, without having to take into consideration the usual parallel shaft-lines terminating in a rope race over the engine house.

The above are only a few of the advantages to be gained by the adoption of electricity, but they will be sufficient to show that an electrical drive is very much more flexible in every way than a mechanical system.

In regard to the electrical system to be employed, undoubtedly a three-phase has many advantages over a direct-current system, the most important being the high starting torque and overload capacity of the motors, and also the elimination of brush gear, thereby reducing attendance to a minimum.

Where machinery is driven in groups,

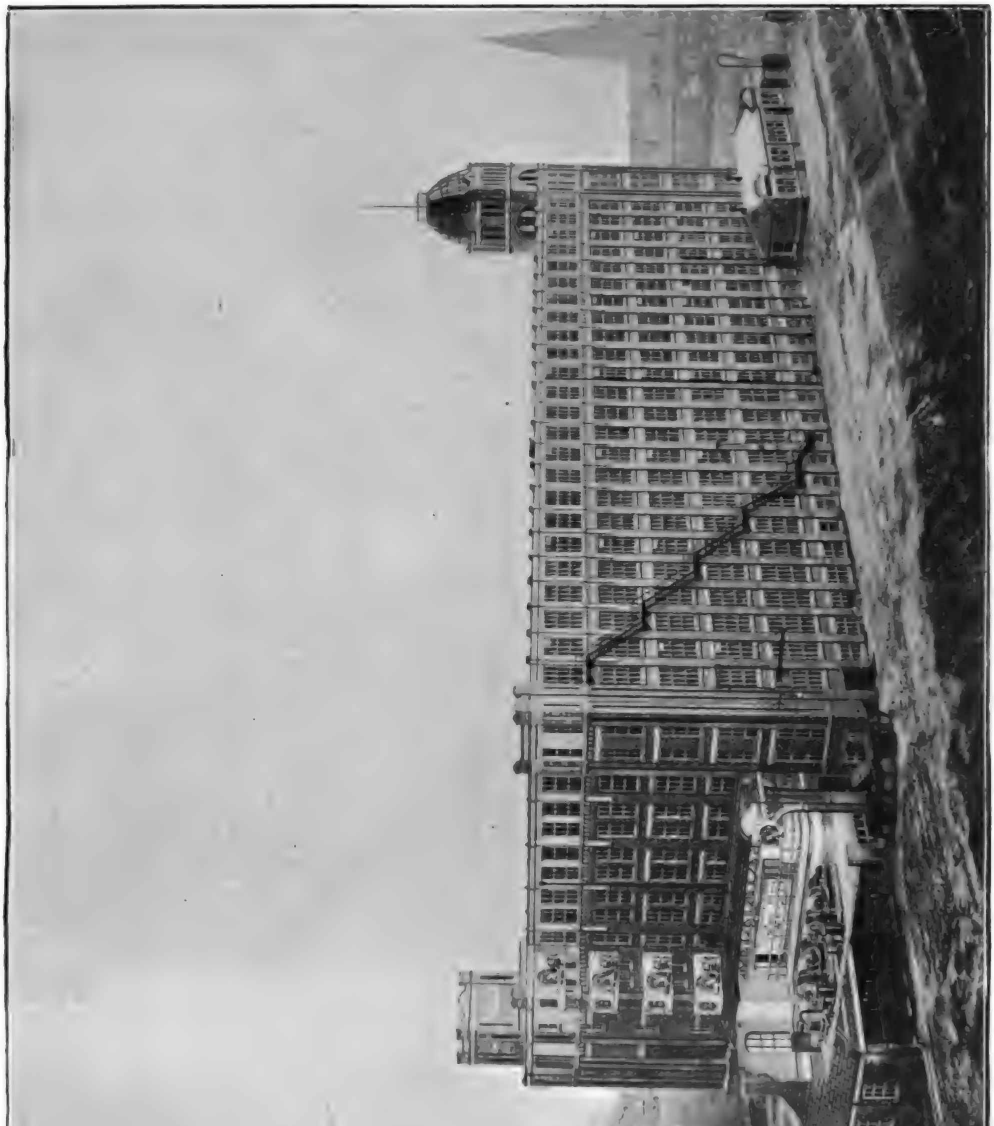


Fig. 1. General View of the New Mill of The Kearsley Spinning Company, Ltd., Showing the Arrangement of the Electric Driving Plant.

which system is usually advocated in the sections of the mill which have infrequent stoppages, the motors are generally coupled direct to line shafting, the shafts being driven at about 360r.p.m. for the cards and other comparatively slow running preparation plant, and 480r.p.m. to 580 r.p.m. for the other machinery.

For driving machines which have frequent stoppages, individual motors are generally employed either coupled-direct or through gearing.

Although in the case of mules stoppages are rather frequent, individual drive is not to be recommended, as the power required on the reversal of each mule is very much above the normal, and if individual drive were employed it would necessitate large

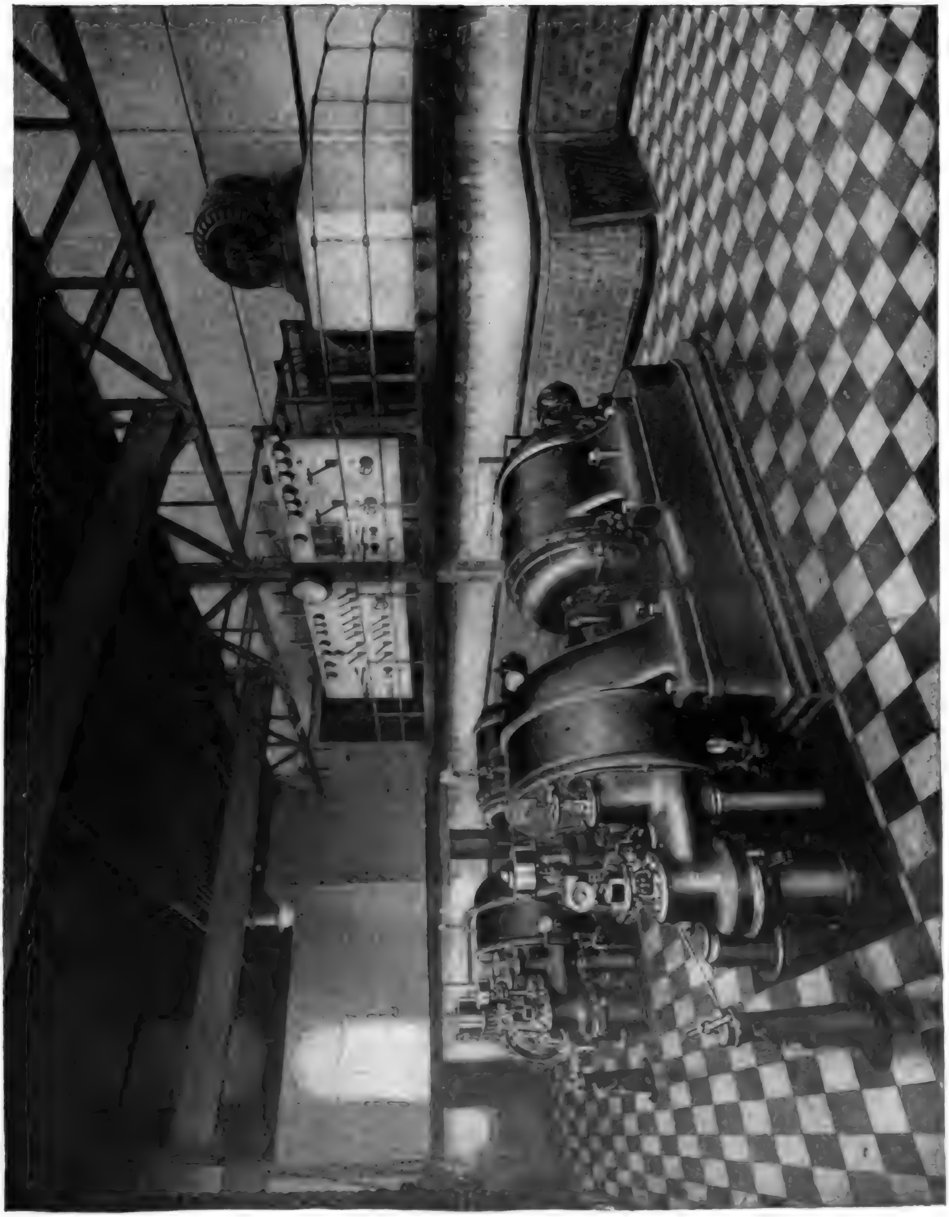


Fig. 2. Interior View of the Electric Generating Station.

motors, which would result in low efficiency and power factor. On the other hand, by driving the mules in fairly large groups the load peaks caused by the reversals practically level themselves off, and motors can be employed with a rating nearer to the average load.

In some special instances individual driving has been applied to cards with advantage.

Owing to the frequent stoppages of ring spinning frames individual driving is undoubtedly the most advantageous, with motors either direct-coupled to the tin roller shafts, or driving same through ropes or spur gearing. The direct drive is the most efficient, as all losses through gearing are entirely avoided, the advantages of gearing chiefly lying in the fact that by its use it is possible to spin different counts in the mill simultaneously, the required speed on the frames being obtained by fitting gears to give the necessary ratio of speed reduction. By coning the motor shafts a change of pinion can be quickly effected, which enables the speed of each individual frame to be altered at will.

The motors, whether driven direct or through spur gearing, are usually mounted in small sheet-iron compartments fitted on the ends of the frames, which, when properly designed, hardly take up more space than the old-fashioned belt driving head. Each motor is arranged to be started or stopped by a switch under the control of the operative.

By the adoption of electrical drive on the above or similar lines it is possible by the elimination of ropes and a quantity of shafting to obtain a higher speed on the machines and steadier drives; thereby securing larger output as well as a more uniform product.

A very important point is the type of generating plant, and undoubtedly the steam turbine has great advantages over the reciprocating engine.

Turbo-generating plant has now been

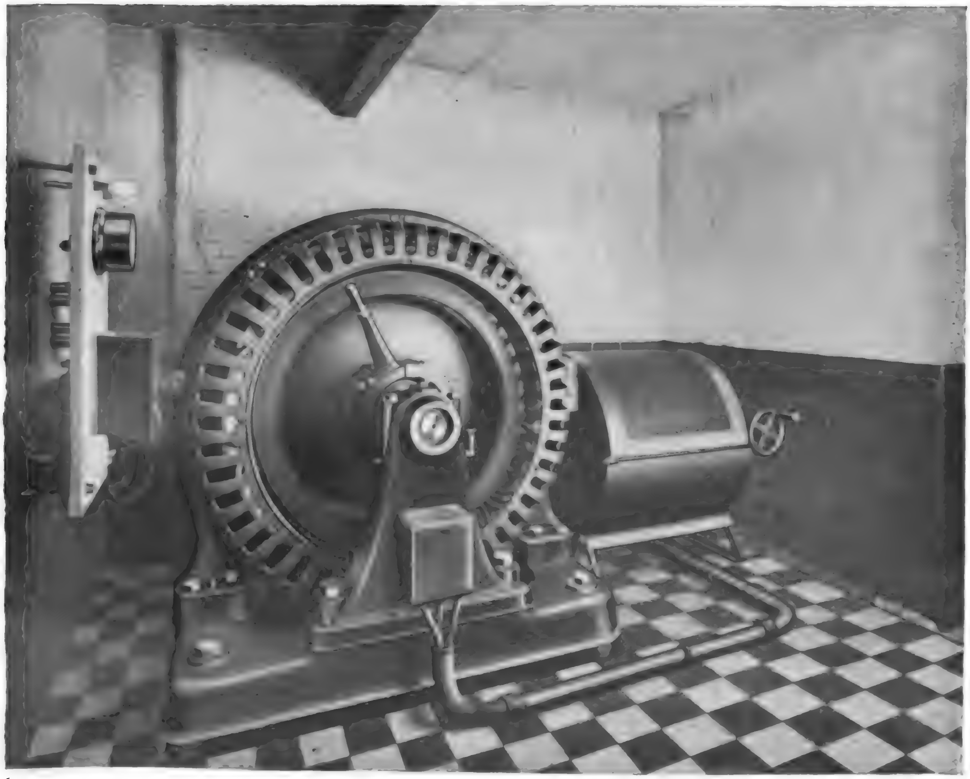


Fig. 3 One of the Spinning-room Motors.

brought to a high degree of excellence and reliability. A few of the advantages to be gained by the adoption of this type of prime mover are the elimination of cyclic variation existing in all reciprocating engines, the minimising of space and foundations, the immunity from breakdown, and in general the simple and stable construction of the plant.

The use of cylinder oil is not necessary, and by utilizing surface condensers the purifying processes in connection with the feed water are avoided, the condensed steam being returned directly to the boilers.

A very good example of a modern electrically driven spinning mill is the new mill lately erected by The Kearsley Spinning Company, Ltd., which has just been equipped by the Electrical Company, Ltd.

The steam-raising plant consists of four Lancashire boilers capable of raising steam at a pressure of 200lb. per square inch, superheaters being provided which raise the steam temperature to 572deg. F.; this plant is working in connection with a battery of economisers, the water being delivered from the hot well to the boilers by means of automatic electrically driven feed-pumps operated by a ball float on the hot well. The generating plant consists of two three-phase steam turbo-generators (A.E.G. system), each designed for a continuous output of 750kw., 500 volts, 50 periods per second, on inductive load with a power factor of 0.8.

This type of turbine embraces many special features, the most important being that it is designed on the velocity principle, the steam being expanded and its pressure energy transformed into velocity energy by means of specially shaped nozzles.

The expansion of the steam is usually carried out in two stages. In the first set of nozzles the steam is brought from boiler pressure down to about atmospheric pressure, at which it passes through the first set of wheels. It is then further expanded from atmospheric pressure down to the pressure of the condenser in the second set of nozzles, from whence it passes through the second set of wheels directly to the condenser. It will be understood, therefore, that in the turbine proper there are no high steam pressures or temperatures existing, and as the pressure on both sides of the turbine wheel is in each

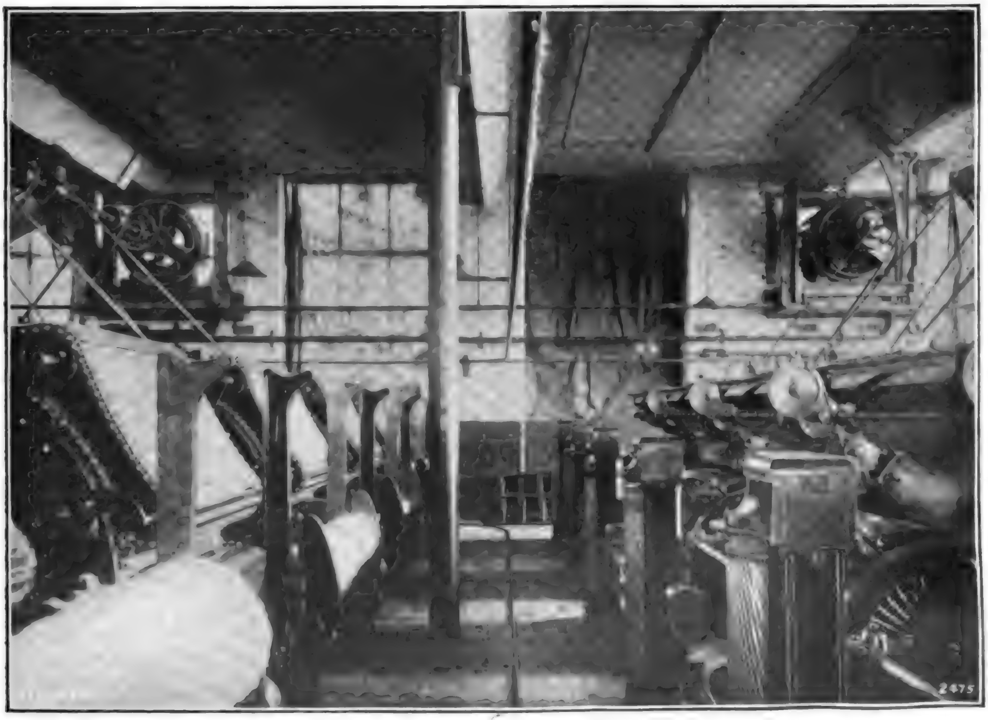


Fig. 4. Motors Driving Card-room Machinery.

case the same, there is no risk of steam leakages through the clearance spacings, and the latter may be made large enough to prevent absolutely all danger of rubbing contact and stripping of blades.

A further advantage gained by the adoption of the velocity principle is that the axial length of the turbine can be kept very small, which fact assists in maintaining great mechanical stability, prevents whipping of the shaft, and saves valuable space in the engine room.

The generator is of a particularly solid and stable construction, the rotating field possessing the characteristics of a solid cylinder. By a special system of ventilation and by water circulation in a double casing round the generator carcase, the entire generator is kept particularly cool. The turbine also runs practically noiselessly owing to the construction of the stator, which does away with the disagreeable noise or shrieking often set up by the ventilating discs in other types of plants.

Each turbo-generator has its own exciter direct-coupled to the main shaft, the voltage of excitation being 110. By means of a "Tirrill" regulator, which automatically adjusts the excitation, the terminal voltage on the generator is kept absolutely constant irrespective of load fluctuations.

Each generator unit is complete with its own independent surface condensing plant, circulating pump and air pump. The condensers are placed immediately under the turbines, and are designed to maintain a vacuum of 28in. at full load when utilising about 1360 gallons of cooling water per set per minute at a temperature of 65deg. F.

The switchboard is specially designed with all current-carrying parts at the back, the switches being operated by levers passing through the marble. Each motor has its independent switch and ammeter on the main board.

With the exception of four card-room motors, all motors for the driving of the mill are placed in a tower at the end of the mill immediately over the turbine house.

The motors for driving the spinning rooms are of the slip-ring type operated by liquid starters, and each of these motors has its own switch-panel with ammeter, triple-pole switch and no-voltage release. These motors are direct-coupled to the main shaft passing down the full length of the room, and in each case twenty-four mules of about 1350 spindles each are driven by one motor, the shaft speed being 485r.p.m.

Respecting the preparation plant, the cards, drawing frames, &c., are driven by three motors each coupled to a line-shaft, the shaft speed in this case being 360r.p.m. These motors are of the squirrel-cage type, being controlled directly from the engine-house switchboard by starting transformers. The motors are enclosed in special housings built into the main wall of the mill, the housings being ventilated by direct access to the outside air. Two separate motors are provided for driving the shafts in connection with the blowing room and flyer frames, *i.e.*, slubbers, intermediates, and rovers; the shaft speed in each case being also 485r.p.m.

There is also a separate motor 720r.p.m. for driving the bale-opener, lattice-feeders, &c., in the basement.

The lighting of the mill is carried out independently of the power plant, the current being obtained from a high-speed set consisting of d.c. generator, 75kw. capacity, 220 volts, direct coupled to a high-speed steam engine.

The accompanying illustrations show clearly the general features of the electric equipment. The arrangement of the generating station and position of the large motors driving the spinning rooms is seen in Fig. 1. The illustration Fig. 3 shows one of the spinning-room motors in its own fire-proof chamber, whilst in Fig. 4 is shown the method adopted for driving the line-shafts of the card room.

It may be mentioned that from the outset the plant has been running without any hitches, and although complete tests have not yet been made respecting the power consumption and yarn produced per horse-power generated, the steady and uniform driving obtained through the medium of turbines and large motors has undoubtedly had the result of producing the very highest class of yarn.

Modern Electro-Textile Machinery and Appliances, Auxiliary Apparatus, &c.

Power and Speed Tests in Textile Mills.

Geo. Thomas & Co., ***Manchester.***

It is of vital importance that mill-managers should take and record statistics not only of speeds but also of the power used by their machinery, thus controlling the efficiency of their machines and verifying that they are getting throughout the mill the best possible results.

To meet this requirement Messrs. Geo. Thomas & Co., Manchester, are introducing a new patent transmission dynamometer or "power weighing scale" which weighs the transmitted power in a manner as definite and actual as that in which objects are weighed on the ordinary platform weighing machine. Further this new type of instrument is fitted with many improved features, all giving greater accuracy in use, the most notable addition being an ingenious tachometer arrangement; this latter is most indispensable because to ensure an accurate result the stress and speed indications should always be *simultaneously* recorded. If the latter be not done the reading is rendered uncertain by periodical fluctuations of speed caused by slipping belts, &c. The test operation is most simple, the apparatus being designed so

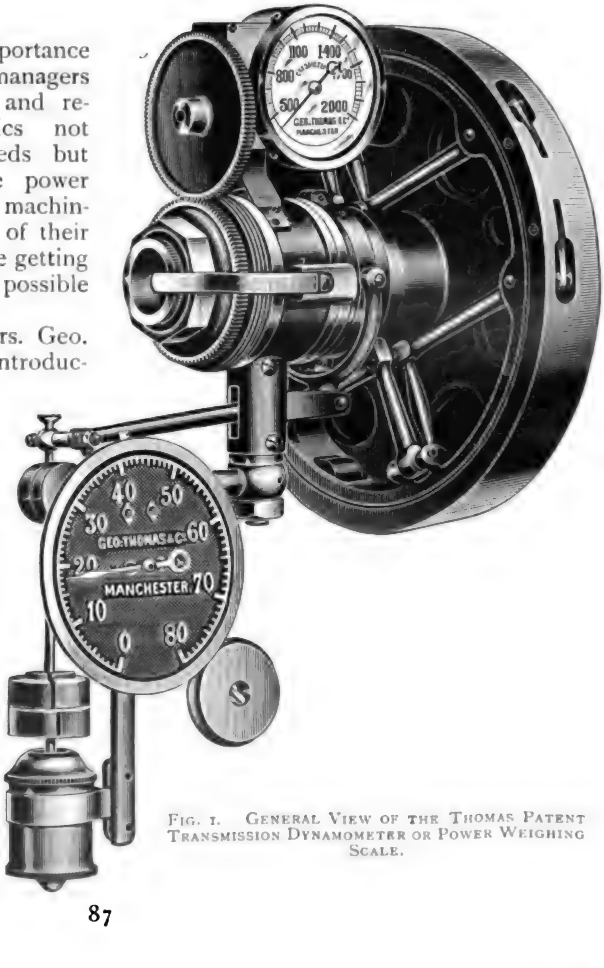


Fig. 1. General View of the Thomas Patent Transmission Dynamometer or Power Weighing Scale.

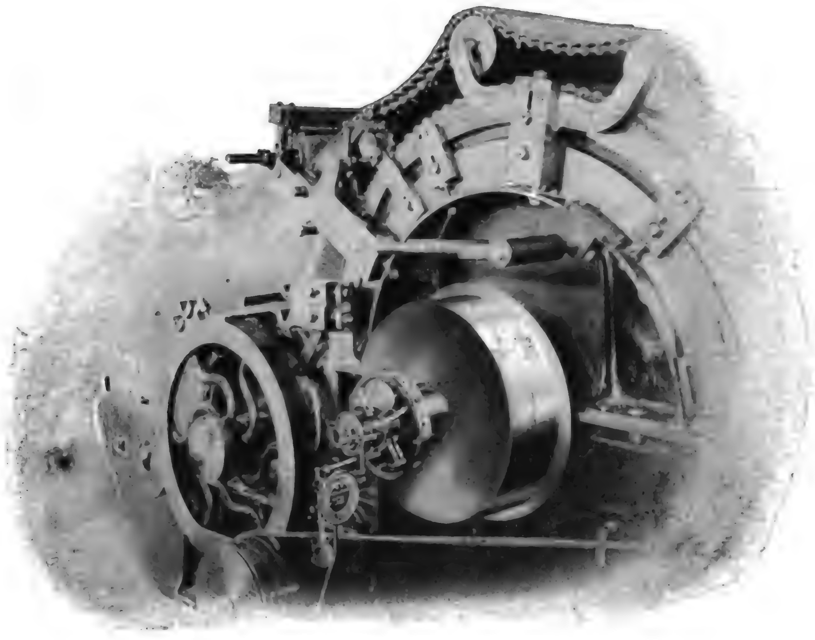


Fig. 2. Dynamometer applied to Carding Machine.

as to obviate long calculations, *e.g.*, when the net load indicated on dial is 50lb. this × 2 (the driving pin of the dynamometer describes a 2ft. circle) = 100ft. lb. per revolutions—multiplied by the r.p.m. (shown by tachometer), say 660 = 66,000ft. lb. per minute. Thus the h.p. =

$$\frac{50 \times 2 \times 660}{33{,}000} = 2\text{h.p.}$$

Having thus obtained the h.p. for the frame (or machine under test) it is an easy matter to work out the h.p. per spindle, or number of spindles per h.p., &c., &c.; also a complete set of tests should be made, *i.e.*, with bobbins empty, half-full, and full one side of frame only; then the other; then with only the spindles running, &c., &c. The obtained data are tabulated and serve as basis for bringing up all frames, &c., to the highest efficiency; in some mills users of this dynamometer have located grave faults of slippage, faulty erection, defects in alignment, &c., and the correction of these faults has in a very short time repaid the cost of the apparatus and time spent on tests. The illustration in Fig. 1 shows the dynamometer of the

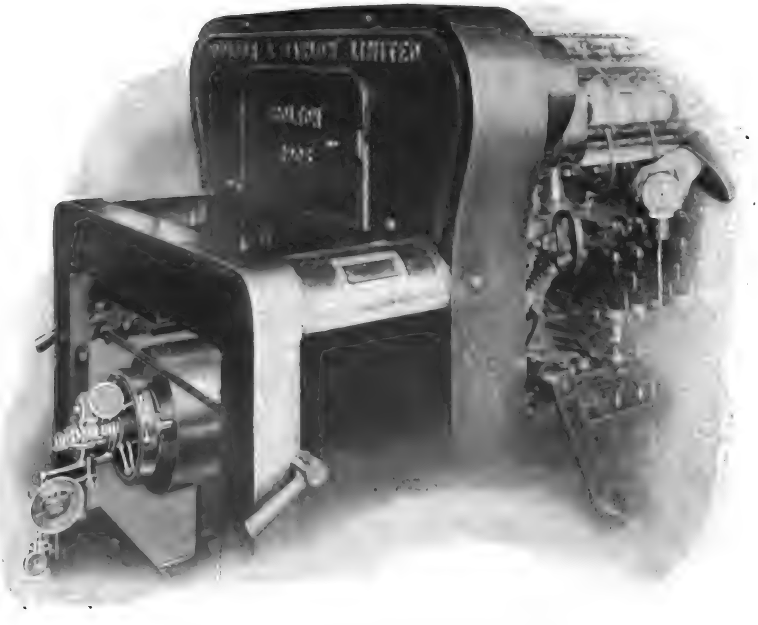


Fig. 3. Dynamometer applied to Ring Frame.

Fig. 4. The Horn Portable Spring-axis Tachometer.

mill type, and the views Figs. 2 and 3 show the apparatus in use on card machine and ring frame respectively, the belts having been removed for photographing purposes.

In addition to the type illustrated in Fig. 1, which is adapted specially for cotton mill requirements, heavier models are supplied for general and special purposes, which differ in that they are available for only one direction of rotation; moreover they are not applied to the end of the shaft, but are of the split type, thus being available for application to countershafting, &c.

Messrs. Geo. Thomas & Co. also make a speciality of speed indicators. Their type is known as Horn's patent portable tachometers, which indicate direct on the dial at the instant of contact, and, without any timing or calculation, the r.p.m. made by spindles, shafting, engines, dynamos, &c.

So very many of these instruments are in use that they are no longer a novelty, but many readers may not have had the opportunity of seeing the latest pattern, which is illustrated in Fig. 4. This instrument is fitted with a patent spring axis, which accelerates tests by obviating the necessity of changing the connection piece from one axis to another; it has also other advantages over the earlier patterns. The illustration, Fig. 3, shows the tachometer in use on a ring-frame.

This firm has also had much success with Horn's patent stationary tachometers and tachographs, the latter, of course, being of special value for taking permanent paper-records or speed-diagrams of engines, motors and various machinery. These instruments are also supplied, when required, fitted with steam-pressure recorder. The tachographs are supplied in a variety of patterns for various requirements, Fig. 5 showing one of the forms in general use for belt connection to machines.

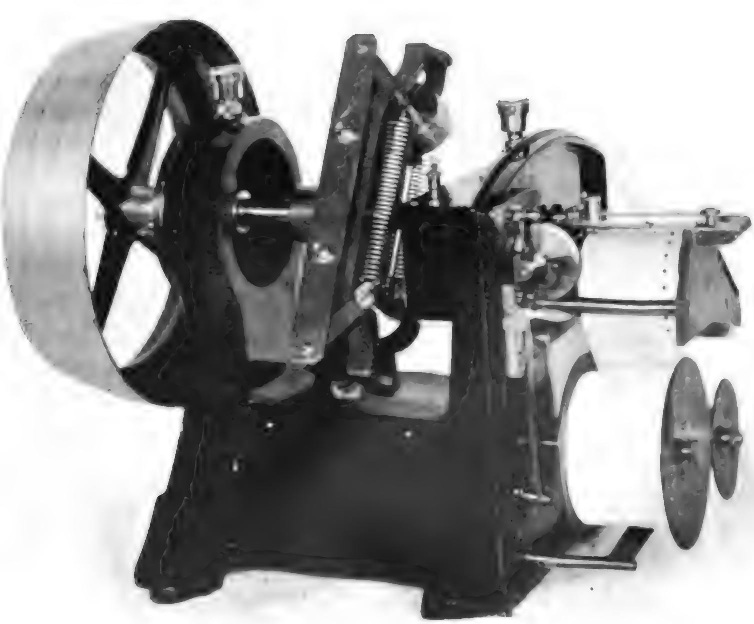


Fig. 5. One Form (Type A) of the Horn Tachograph.

Power Transmission.

James Hendry, Glasgow.

THE question of efficiency is ever uppermost and calls for the first consideration of every branch of the mechanical world. It is the recognition of this fact and rising to the occasion that assures success. To establish this truth one need only take into consideration the many and various improvements present-day requirements have brought about, as a walk through any of the large modern manufacturing shops amply testifies. It is, however, not sufficient to modernise on the one side only, for whilst old plant may have been thrown out and discarded for modern machinery, doing double and treble the former outputs, improvements require to be carried out individually or collectively as the case may be, so as to enable each and every machine to perform its work efficiently, and thus is introduced an item which calls for constant special attention, namely, transmission of power.

The manufacture of a thoroughly efficient driving band has had the special study for many years of Messrs. James Hendry, the well-known Glasgow firm; this work, backed up with great commercial success, forms the sure guarantee and testimonial to the makers' claim that Hendry's patent laminated leather belting is one of the best yet offered to the public. It is made in any length free from splicings, thus eliminating the many defects only too well known and recognised by the engineer. It runs perfectly noiseless, straight and true, and when spliced is of uniform strength and thickness throughout. The particular manner in which the belt is built on edge, combined with the specially-prepared sewing material, gives the belt, even in the larger or thicker sizes, a degree of flexibility which cannot be equalled in any other make of belting.

It will be readily seen, with this particular advantage, that the belt has a perfect grip throughout its whole length and breadth, the load being equally and efficiently distributed over the driver and driven pulleys.

Another great feature of the belt is its adaptability to perform its work from the very moment of fitting, the old trouble of stretch and subsequent delays being a thing of the past. In joining the belt the two ends are dovetailed together, thus forming themselves into and becoming the identical same substance throughout, making an absolutely endless belt. It is claimed for the Hendry belt that its qualifications leave nothing to be desired, and that a trial will amply prove its superiority and peculiar advantages. For electrical power work where belt transmissions to dynamo or from motor are required there is particular scope for belts of this description: large powers, high running speeds and comparatively small diameter pulleys are common in electrical power service, and consequently the belt, which is of uniform thickness, good gripping surface, and non-stretching, is bound to be preferred.

"Igranic" Automatic Self-Starting Rheostats.

Adams Manufacturing Co., Ltd., Bedford.

THE starters described illustrate the remarkable convenience and flexibility of an electrical power service. Motors can be started and stopped automatically by the mere falling and rising of a float or the depressing of a push button at any distance away from the motor itself. The two forms

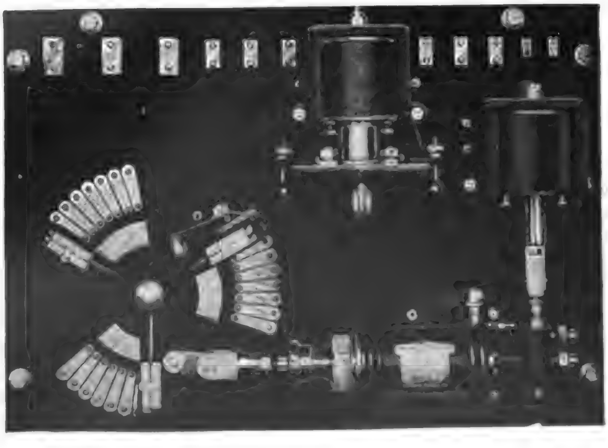


FIG. 1. THE "IGRANIC" SELF STARTER FOR SQUIRREL-CAGE MOTORS.

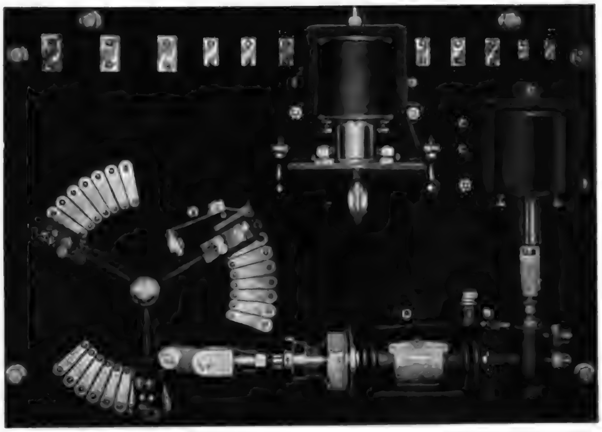


FIG. 2. THE "IGRANIC" SELF-STARTER FOR SLIP-RING TYPE MOTORS.

illustrated are both for use with alternating-current motors. The type shown in Fig. 1 is designed for use with two or three phase alternating-current motors of the squirrel-cage type. It is arranged to start up the motor with resistance in its primary circuit, and is designed for use only when the torque required to accelerate the motor is not in excess of the normal running torque, and when not more than 150 per cent. of the normal current is required to develop this torque.

The form of self-starter shown in Fig. 2 is designed for use with two or three phase induction motors of the slip-ring type, the armatures or rotors of which are wound in sections and provided with collector rings, so that starting resistance may be introduced into the rotor circuit. The motors are controlled by a switch in the primary, or stator, circuit, and are accelerated by resistance in the rotor circuit. For two-phase alternating-current systems, the primary circuit to the motor is controlled by a single-pole switch in each phase. For three-phase systems, the primary circuit is controlled by a switch in two of the three phases, the third-phase being connected direct to the motor. For either two or three phase motors of the slip-ring type, it is standard practice to supply three-phase wound rotors, so that for either type of motor, starting resistance will be supplied in each of the three phases of the rotor.

The self-starter consists of a slate panel containing a double-pole, oil-immersed, solenoid-operated line switch; a resistance commutator and resistance; a device for moving the rheostat lever; and a solenoid for the control of this device. It may be controlled by a push button, air pressure regulator, float switch, or tappet switch, depending upon the machinery to be driven. The motor is started by the closing of the line switch, which closes the primary circuit to the motor through the starting resistance, and thereafter the mechanical device operates to cut the starting resistance out of circuit and bring the motor up to speed. The motor is stopped by the opening of the main line switch, and thereafter the rheostat is automatically returned to the starting position, so as to be ready to start a second time.

The mechanical device for operating the rheostat lever consists of a cylinder and piston arranged for operating both ways with power, and its operation is controlled by a valve, in turn controlled by a single-phase alternating-current solenoid, which is excited on the closing of the main line solenoid switch. Water or air at moderate pressures may be used to operate this device. Water may be taken from the town main, if desired.

These automatic starters have been standardised in sizes up to 150b.h.p., but can be furnished in much larger sizes if required. They are an example of a practical application of an alternating-current solenoid to switch-closing, and represent a solution of the problem of obtaining a reliable automatic motor controller and starter whose cost is not prohibitive.

Some Textile Installations.

Phœnix Dynamo Manufacturing Company, Ltd., Bradford.

SITUATED in the heart of a great textile district, the Phœnix Dynamo Manufacturing Company, of Bradford, are in the best position for entering properly into the engineering details of the electrical requirements of textile factories, and there is little wonder that they have done very considerable practical work in this direction.

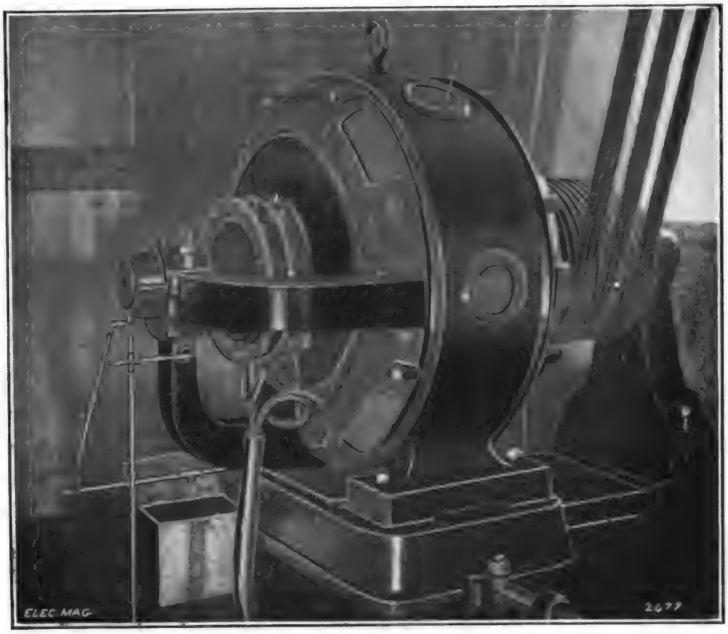


Fig. 1. 100h.p. "P.D.M." Motor driving Spinning Mill.

a 100kw. three-phase "P.D.M." alternator direct-coupled to a Browett-Lindley high-speed engine. The distance between the generating plant and the 100h.p. motor is about 150 yards. This installation has been in constant use for about two years in a well-known mill in Yorkshire.

Another installation comprises a 100kw. rope-driven direct-current "P.D.M." generator, which supplies several motors, including the one shown in Fig. 2. This is of 40h.p. capacity, and supplies power to two main line-shafts driving 40in. looms.

The several illustrations on this and the following page speak for themselves as to the class of work carried out.

In the case of the motor shown in Fig. 1 the rope drive extends up to the second and third storeys for the driving of spinning mules. The electric power is generated by

The illustration Fig. 3 shows a 25h.p. motor driving by belt and line-shaft a number of cotton-spinning self-acting mules. The machine is of the "P.D.M." direct-current protected type, of which a large number are in use and on order for this particular class of service.

A noteworthy feature of the plant shown

Fig. 2. 40h.p. "P.D.M." Motor driving Looms.

FIG. 3. 25H.P. DIRECT-CURRENT "P.D.M." MOTOR DRIVING SELF-ACTING MULES.

in Fig. 4 is that the motors have been continuously in service night and day (except Sundays) for some years. The motors are of the 20h.p. size, driving worsted carding machines.

In the Bradford district alone this company has installed upwards of 500kw. of electric plant for textile mill driving. That these installations are doing good work is confirmed by the fact that orders are now in hand for over 1000kw. of plant for similar service.

In addition to electric plant for power requirements in textile factories, this company has in hand at the present time a great many dynamos to be supplied for the generation of current for the electric lighting of mills.

FIG. 4. TWO "P.D.M." MOTORS EACH OF 20H.P. DRIVING CARDING MACHINES.

The "Climax" Horizontal Type Water-Tube Boiler.

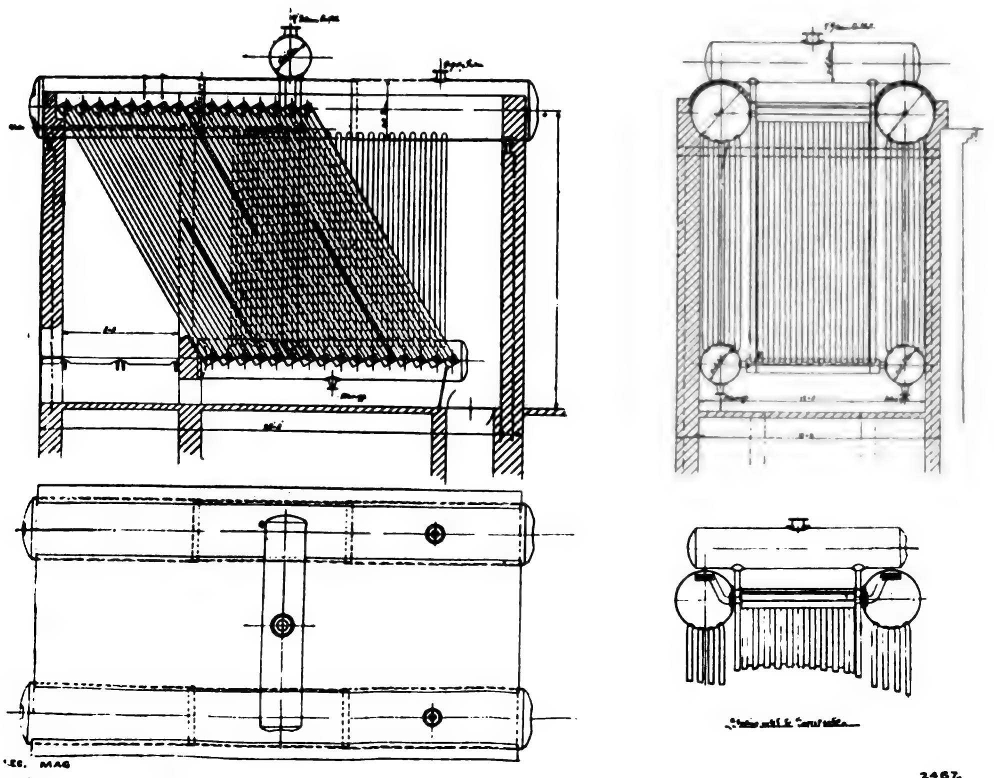
B. R. Rowland & Co., Ltd., Reddish.

WATER-TUBE boilers, embodying recent improvements, form the steam generating portion of electrical plants which are being installed for driving the whole of the machinery in two new cotton mills in course of erection in Lancashire, namely, the Thor Mill, Whitworth, and the Ark Mill, Stockport.

There will be a plant of three boilers, each of 10,000lb. hourly evaporative capacity, at each mill, and each boiler will be fitted with steam superheater and feed water heater. The constructional arrangement of the boilers will be readily understood by reference to the illustrations appearing below. Though having a somewhat similar outline to an older type of water-tube boiler, the construction is essentially different in that the sections of tubes are placed broadside with the path of the gases, thus allowing of all the tubes in each section being equally heated. Each section is provided with two inlets and two outlets, and there are four or more down-take tubes for each section of tubes employed, thus providing the necessary freedom for circulation. The water or mud drums are of large capacity and are placed out of direct contact with the flow of gases, thus improving their utility as collecting chambers for impurities or scale-forming material. The tubular sections are connected at the upper or outlet ends to the two steam and water drums at the water line, thus providing for a steady and uniform water level in both drums.

The superheater and feed heater are provided for by merely employing additional sections of tubes and connecting them at one end to the boiler drums.

The floor space occupied by one of these installations of "Climax" boilers of 30,000lb. hourly evaporative capacity is but thirty-eight feet by nineteen feet.



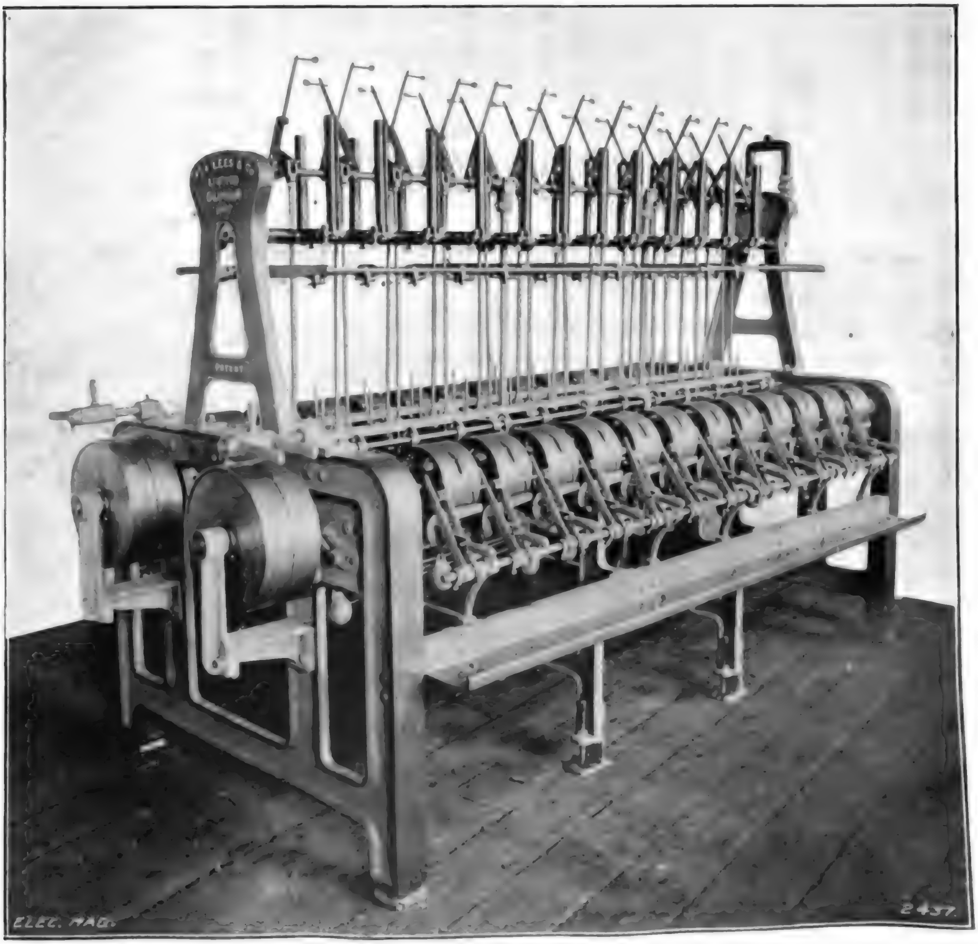
SHOWING THE GENERAL ARRANGEMENT OF THE "CLIMAX" WATER-TUBE BOILER.

An Improved Gassing Frame.

Asa Lees & Co., Ltd., Oldham.

A DISTINCT improvement in the means of gassing or singeing yarn has been developed by Mr. F. Rivett, of Stockport, the outcome of which is the machine illustrated below. This gassing frame is manufactured by Messrs. Asa Lees & Co., Ltd., of Oldham, the well-known textile machinists. The process of gassing consists in passing thread or yarn continuously through a flame which singes off the protruding fibres and leaves the thread uniform and of good smooth surface. In this manner sewing cotton and lace threads are finished.

In this new machine, instead of having the gas-burners placed just above the frame cross-rail, they are placed much higher up in the frame, and the gassing is effected in a different manner. The main feed pipes for the gas run the full length of the frame on both sides of the stands, and from these pipes, opposite each drum, small jets protrude, which serve as the burners. Each of the burners is encircled by a vertical shield, which forms a chamber wherein the flame burns. The yarn, in going from the delivery bobbins to the cheeses, passes through the chambers in an upward direction, and on its way encounters the flames from the gas jets. The shields or chambers are each provided with slotted



IMPROVED GASSING FRAME. ASA LEES & CO., LTD. RIVETT'S PATENT.

openings, extending from the top to the bottom, so that the yarn can be quickly thrown into contact with the flames after piecing-up has been effected. The levers that control the yarn guides are connected with those carrying the spools, so that the two act synchronously; therefore, when the spools or cheeses enter into contact with the driving drums, the yarn is immediately put into the flame, and *vice versa*. Practice with this system of gassing has shown that the frame can be run at a much quicker speed than is usual with the older forms of machine: in fact it is stated that the increase is as much as from four to six times the speed at which yarn is gassed under the ordinary conditions. This great increase in the working rate necessitated the introduction of a quicker method of traversing the yarn across the spools than that obtained by the ordinary cam reciprocating motion. As a consequence came the adoption of what is commonly known as the split-drum system. In adopting this method has been introduced a further improvement in the form of a short slot in the shell of the drum, in addition to the usual one for controlling the traverse. By this means the thread is brought readily into position for the winding, and at the same time the operative is saved the trouble of guiding it there. After piecing-up the operative simply releases the thread, which, as soon as it becomes taut, falls into the auxiliary slot, whence it is immediately guided into the one for controlling the traverse.

It is claimed for this machine that, in addition to increased output per frame, there is a better degree of combustion of the extending fibres, and therefore no smoke and less accumulation of deposit on the frame. There is also an increased economy in the consumption of gas. Owing to the fact that the fumes from the gases are discharged overhead, there is the further advantage that the atmospheric conditions under which the operative works are less injurious.

Messrs. Asa Lees & Co., Ltd., are the sole makers, and, as will be gathered from the illustration, they have combined strength with neatness in this new machine. The design is very suitable for easy arrangement for electric driving. Each side of the frame is driven separately, and change-wheels are provided, by means of which the speed of the drums can be altered independently. The drum-shafts run in self-oiling bearings, and the parts are made to templates and are interchangeable. The firm has already acquired a world-wide reputation for excellence of product; it would seem, therefore, that this improved machine with its remarkable efficiency and all-round advantages is assured of general adoption.

Automatic Stokers and Forced Draught.

Meldrum Bros., Ltd., Manchester.

THE firing of boilers is one of the most important factors in the economical production of steam power, and whilst, with a careful fireman, good results can be obtained from hand-fired boilers under natural draught, firemen of this description are not very common, hand-fired boilers frequently being far from efficient, whilst smoke is generally a source of considerable trouble.

In the attempt to improve upon these conditions, many kinds of mechanical stokers have been put on the market and have met

FIG. 1. RANGE OF BOILERS FITTED WITH MELDRUM STOKERS AT LARGE COTTON MILLS.

with varying degrees of success. The older types of stokers were fairly satisfactory as regards smoke prevention, but one great disadvantage attending their use has been that only a very moderate rate of evaporation could be obtained from the boiler. Of late years, however, this difficulty has been entirely overcome, and stokers are now obtainable which will keep smoke well within the necessary limits, and also give a much greater output of steam than can be obtained by hand-firing with natural draught.

The sprinkling and coking stokers made by Messrs. Meldrum Bros., Ltd., are on these lines. Space will not allow of a detailed description of the respective methods of fuel feed indicated by the term "sprinkling" and "coking" respectively, but the outstanding feature of this particular make of stoker is the method of air supply.

The air required for combustion, both primary and secondary, is supplied by means of the well-known Meldrum steam-jet blowers. The supply of air is thus strictly under control according to the rate of combustion required, waste and loss of efficiency through excess air passing through the furnaces being, to a very large extent, obviated.

Important installations of these stokers are working in most of the great industries of the country, the textile trades not excepted. Perhaps the best evidence of their practical success is afforded by the fact that they have been largely adopted by the great firms of Messrs. J. & P. Coats, Ltd., and Messrs. Clark & Co., Ltd., of Paisley. For these associated firms Messrs. Meldrum have supplied, or have now in hand, stokers of the sprinkling type for twenty-one Lancashire boilers. These orders were placed

FIG. 2. MELDRUM COKING STOKERS AS APPLIED TO LANCASHIRE BOILER.

after very lengthy and exhaustive tests carried out on one set of stokers, the results in regard to combined high evaporative power, smokeless working, and fuel economy, showing that the Meldrum stokers were much the most efficient of the several types under observation.

Another instance is that of one of the most important cotton-spinning and manufacturing firms in Lancashire, who have had these stokers applied to twenty-eight Lancashire boilers and have found them excellent for heavy steam production and freedom from smoke.

The stokers are suitable for water-tube as well as Lancashire boilers. The Bristol Corporation Electricity Works have twelve large Babcock and Wilcox boilers fitted with these stokers, which have proved remarkably successful, and a further group of four still larger boilers is now being equipped with similar apparatus.

Although usually combined, as already mentioned, with the special system of controllable air supply, the stokers can, when so desired, be arranged for working with simple chimney draught, or with fan-induced draught, and successful installations of each kind are at work.

Water-tube Boilers in Cotton Mills.

Babcock & Wilcox, Ltd., London.

ALTHOUGH textile mills form one of the principal of our staple industries, they have perhaps been more conservative than some other industries in the arrangement of their plant for power production, while spending a great deal of care on the improvement of the actual machinery for spinning, weaving, &c.

Latterly, however, engineers have begun to recognize that in addition to the economies to be obtained by the use of the latest machinery in the textile portion of the works, it is possible to obtain a very fair percentage of increase in this direction in the boiler house, and a still further increase in economy, it is claimed, is obtained by the application of electricity, hence the advance made in this direction by Messrs. Ashworth, Hadwen & Co., of Droylesden, near Manchester, in installing a three-phase electrical generator and motor equipment for their mills.

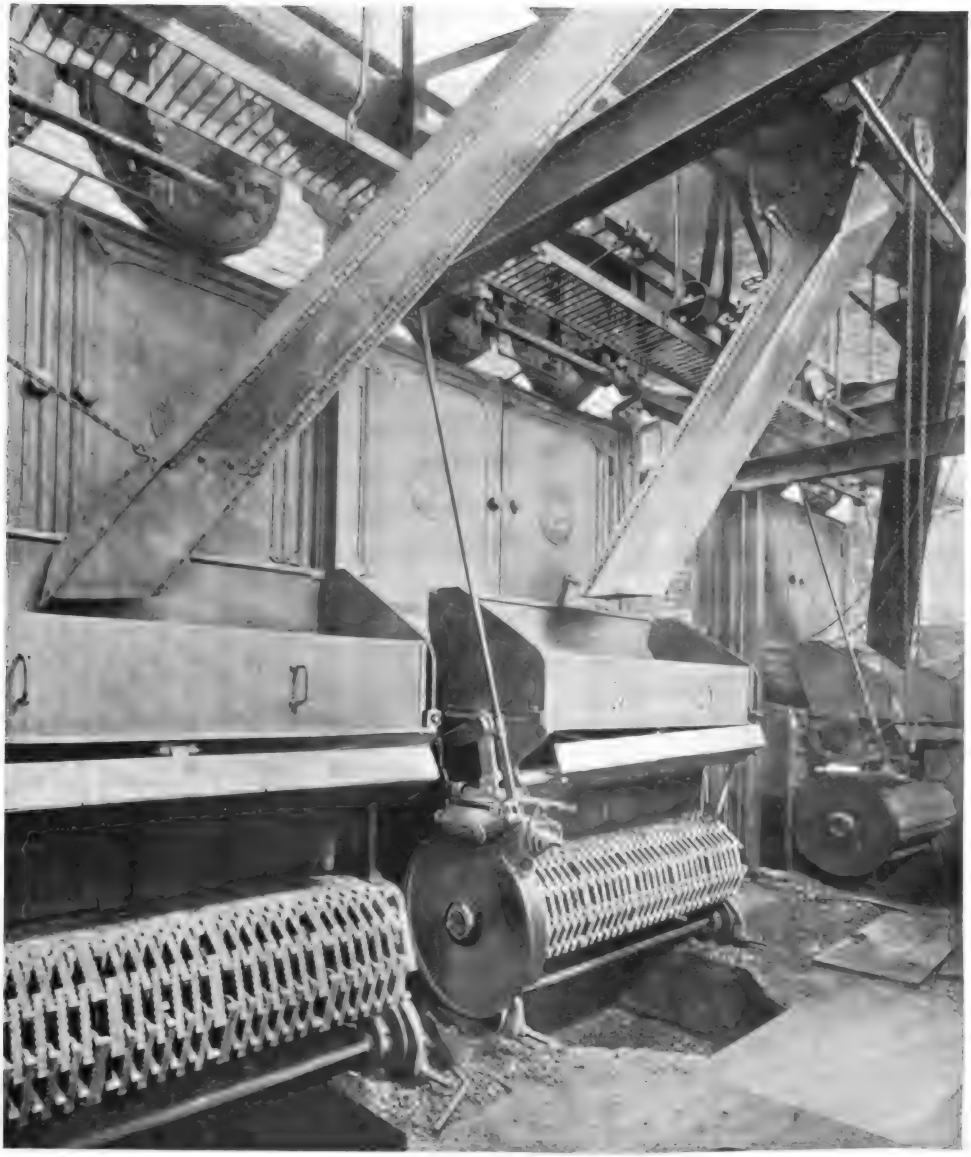
The mill, it appears, dates from the year 1840, and previous to the alteration a large beam engine of 1000h.p. running at 23r.p.m. was in use, the power being transmitted to the machines through shafting. In place of the above a steam turbine is now employed running at 1500r.p.m. direct-coupled to a three-phase electric generator. Steam under the new conditions is provided by three Babcock & Wilcox boilers, each having 2437 sq. ft. of heating surface, constructed to work at 180lb. pressure per sq. in., consisting of 12 sections of 4in. tubes, each section nine tubes in height by 18ft. in length; surmounted longitudinally by two 36in. drums. The steam fittings are of the "Hopkinson" make. Each of the boilers is fitted with the Babcock & Wilcox integral patent superheater, arranged to give a superheat equal to 160deg. F. The boilers are each also fitted with the makers' patent chain-grate stoker.

There is, of course, no particular novelty in the employment of the Babcock & Wilcox boiler for an electric generating plant, as upwards of 1,000,000h.p. with these boilers is in use in the United Kingdom alone for this purpose, while in connection with textile mills working principally by the older methods, upwards of 200,000h.p. of Babcock & Wilcox boilers have been installed in different places throughout the world; in fact, it would seem that in some countries, as for instance in Russia, textile engineers have been more alive to the advantages of the modern water-tube boiler than have our own engineers, partly, perhaps, because their mills have been erected more recently than the majority of those in our country.

As competition increases, it is therefore important to engineers in textile industries to bear in mind that they can still fall back upon one method of increasing their profits, viz., by overhauling old-fashioned plants and bringing them up to date on the lines suggested above.

Messrs. Ashworth, Hadwen & Co., it is said, enjoy the distinction of being the first mill-owners in Lancashire to adopt the electrical method of running their mill machinery.

The results of the working in their case will no doubt be followed very carefully by other engineers in the same business, and gradually the local prejudices in favour of the older methods will disappear.



Ashworth, Hadwen and Co., Droylesden Cotton Mills.
Three Babcock and Wilcox Boilers, each of 2437 Square Feet Heating Surface, Fitted with Patent Superheaters and Patent Chain-grate Stokers.

The Textile Equipment of the Acme Mill.

Brooks and Doxey, Ltd., Manchester.

ALTHOUGH the splendid new factory of the Acme Spinning Company, Ltd., at Pendlebury, near Manchester, was only put up two years ago, it was the first cotton spinning mill in Lancashire to be entirely driven by electricity. It has no engine and boiler house, and consequently no chimney, as the whole of the driving power is obtained from a local electricity supply company, the Lancashire Electric Power Company, Ltd.

The system of driving as adopted is the use of a separate motor attached to each line-shaft, the various textile machines themselves being driven in the ordinary way by belts or ropes. Apart from the novelty of electric motive power, a most important feature of the installation is the high-speed small diameter shafting which is employed throughout the mill, with the consequent small diameter driving drums; the effect of using these light, higher speed mechanical transmissions naturally results in a very important reduction in the frictional loss of power.

The mill contains about 80,000 spindles, half ring spinning and half mule spinning, spinning average 30s./40s. warp yarns, and 40s./50s. weft yarns.

The following is a full specification of the textile machinery installed:

Two waste pickers or thread extractors; 1 roving waste opener; 2 hopper bale breaking machines; elevating, mixing and distributing lattices; 4 automatic hopper feeders; 4 horizontal openers, with extra porcupine cylinder, and combined with scutchers; 12 single beater scutchers and lap machines (finisher machines); 84 carding engines, 45in. on the wire; 3 drawing frames, 6 heads of 6 deliveries each; 3 drawing frames, 6 heads of 7 deliveries each; 8 slubbing frames, 100 spindles each, 4 spindles in 17½in. gauge, 12in. lift; 19 intermediate frames, 146 spindles each, 8 spindles in 26in. gauge, 10in. lift; 45 roving frames, 184

General View of the Acme Mill, Pendlebury, Manchester.

spindles each, 8 spindles in $20\frac{1}{2}$in. gauge, 8in. lift; 32 ring spinning frames, 384 spindles each, $2\frac{1}{2}$in. gauge, $1\frac{1}{2}$in. rings, 6in. lift driven at one end; 31 ring spinning frames, 696 spindles each, $2\frac{1}{2}$in. gauge, $1\frac{1}{2}$in. rings, 6in. lift, driven and geared at each end; 32 self-acting mules, 1288 spindles each, $1\frac{1}{8}$in. gauge; 5 upright winding frames, 400 spindles each, 5in. gauge; with the necessary beaming machines.

The whole of this machinery was supplied by Messrs. Brooks & Doxey, Ltd., of Manchester, with the exception of the self-acting mules and beaming machines. The mill started working in 1905, and has so far produced very satisfactory results.

Plan of Card Room. The Acme Mill.

Electric Installation Tests.

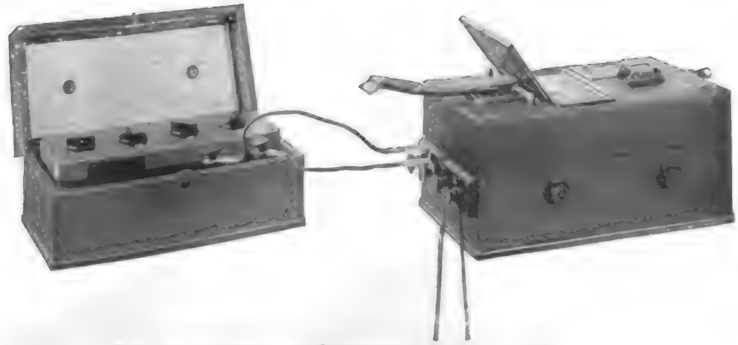
Evershed & Vignoles, Ltd., London.

An extremely useful instrument to have on every electric installation is the Evershed patent Bridge-Megger, by means of which electrical resistances, whether of conductor or insulation, can be readily and accurately measured. It combines a wide range with great speed of working and extreme precision of indication; and has the great practical convenience that the user can take the instrument to the work instead of running leads to the instrument. It requires no preparation and is always ready for use. As its name implies this instrument combines the functions of a Megger or insulation resistance measurer in megohms with those of a Wheatstone bridge or conductor resistance measurer in ohms. In the former case it will determine by direct deflection on the dial any resistance between 0 and 40 megohms, the first division representing 5000 ohms; in the latter case resistances from one ohm upwards can be tested.

The generator is of the constant volts type, and is provided with two windings, which for Megger measurements are coupled in series and give 500 volts. In the illustration the Bridge-Megger box is shown on the right, on the left-hand side is the direct-reading resistance box which is supplied with the instrument for use as the standard for resistance comparisons in bridge measurements. The resistance box contains four sets of coils, being units, tens, hundreds, and thousands of ohms. There is a ratio switch provided which alters the proportion of the bridge arms so that the combination has a total range (as a bridge) of from .01 ohm up to 999,900 ohms. The adjustment of the resistance in the box is effected by four multiple point switches, each carrying a figure dial arranged to show (through a window in the top plate) a digit representing the position of the switch. The total resistance of the box from terminal to terminal is thus given directly in a row of figures so that the resistance is easily read off. There are no plugs to insert or withdraw and no keys to tap. There are no resistance coil figures to hunt for and mentally add. No levelling is required and there is no battery to carry.

The greatest attention has been paid to the design of the switches, which are entirely enclosed, and are not affected by dust or dirt.

The great features of this instrument are its extreme portability and simplicity, and the fact that it can be safely entrusted to the average unskilled attendant of any installation, and moreover that he can be depended upon to get correct results with its use. The economy of keeping a systematic record of the conditions of electric mains and machines in factories and works cannot be gainsaid; the regular testing of insulation will warn one of faults or wastes in the beginning and thus often prevent breakdown and expense in repairs as well as conducing to maintain the highest all-round efficiency of the system. An instrument of the type described very quickly pays for itself.



THE BRIDGE-MEGGER. EVERSHED & VIGNOLES, LTD.

Manufacturers Note.

The Next Special Number of ***The Electrical Magazine*** *will be devoted to the expansion of* ***Colonial Trade*** *and to the great* ***International Engineering and Machinery Exhibition, at Olympia, Sept.-Oct., 1907***

"Ordnance" Centrifugal Fans.

The Electric and Ordnance Accessories Company, Ltd., Birmingham.

THE principal features in the construction of the "Ordnance" centrifugal fans are those which prevent the back-slip of the air through the space between the blades when the fan is operating against a resistance, and also to prevent any churning of the air inside the casing and to give equal efficiency of the fan runner round the whole of its circumference. These various objects are achieved by several special devices adopted in the construction of the fan, one of the outstanding features of which is the patent corrugated blade which by its "spoon"-like shape tends to prevent the back-slip of the air when operating against pressure and which by its special curvature radially impels the air with the greatest velocity in the direction of rotation of the fan runner, thus minimising the bad effects of eddy currents set up by air rebounding from the fan casing.

The impeller is constructed of a number of these corrugated blades closely pitched and firmly riveted to mild steel revolving plate discs, the inside one of which is mounted on a cast-iron hub which again is keyed on the shaft, thus forming the driving side of the fan. The outer ring, which forms the air inlet to the fan, is firmly stayed to the before-mentioned cast-iron hub by means of mild-steel stay rods screwed into special bosses cast on the hub and secured by double nuts, thus forming a very rigid construction.

The casing is supplied with a suction intake eye which is of equal diameter to the impeller, and made easily detachable so that the impeller may be easily removed through this same opening.

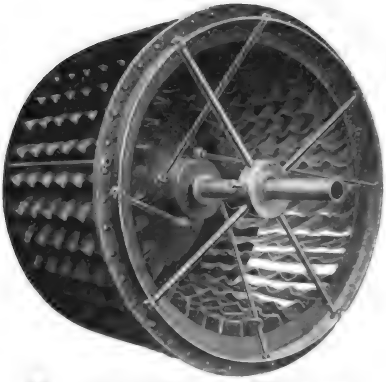


Fig. 1. Impeller of the "Ordnance" Centrifugal Fan.

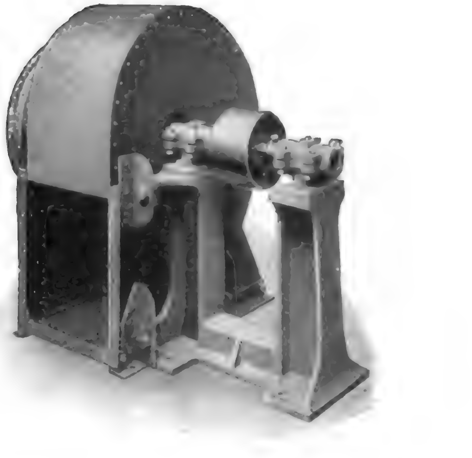


Fig. 2. "Ordnance" Fan, Belted Type

The impeller or runner revolves inside the fan casing, which is constructed of mild-steel plates stayed with angle and "T" iron stiffeners.

In the larger sizes of fans the casings are also split horizontally on the centre line of the fans, thus forming a top and bottom half which again are jointed together by means of angle jointing irons.

These fans are made for many different purposes, and are therefore made in many different types to suit the various requirements of customers. The standard type is arranged for belt drive, but a large number are also in use direct-coupled to continuous and alternating current motors; they are also supplied for direct coupling to steam engines and indeed for all classes of drive. When required for direct coupling to electric motors or steam-engines it is usual to supply the fan with a special outside bearing on the driving side and half-coupling keyed on the end of the shaft for coupling to the motor or engine. The makers also supply a special cast-iron base to take any make of motor or engine, this base carrying a bracket to take the fan bearing. On the larger sizes of fans a bearing is provided on the suction inlet side; this bearing is generally mounted on an "A" shaped cast-iron stand or on a cast-iron wall box, whichever may be most convenient for the case in hand.

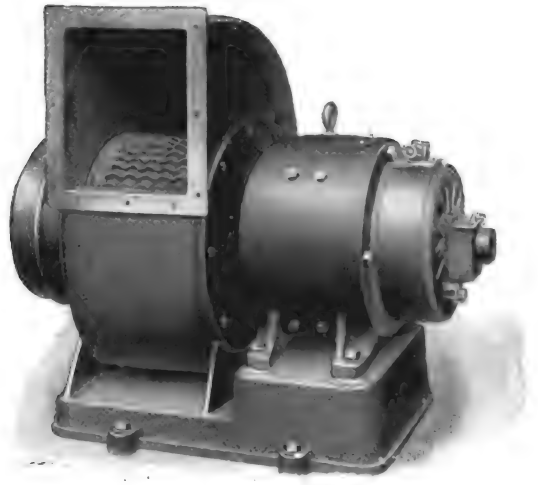


FIG. 3. "ORDNANCE" FAN, ELECTRIC TYPE.

When fans are required to deal with hot gases, as for induced draughts, both the above-mentioned bearings are supplied with water-cooled jackets. All bearings are of the self-oiling type, and lined with patent anti-friction metal. The shafts are made from Siemens-Martin best mild steel and finished bright all over.

The fans are claimed to be of the very best workmanship throughout and are of the high average mechanical efficiency of about 60 per cent.

These fans are applied for a number of different purposes, such as induced and forced draught for factories, electric light stations, and steam power generating plants of all descriptions, mine ventilation, dust removing, ventilation, cooling, the drying of paper and timber, &c.

Factory Power Station Economies.

Mirrlees, Watson Company, Ltd., Glasgow.

EXHAUST steam condensation in connection with factory power plant has not received the special attention which it has in electrical power stations. It has been customary in the past to consider the condenser and air pumps as an attachment or part of the main engine and the efficiency and performance of the condensing plant was never investigated separately from the engine, consequently very few improvements took place in the condenser design excepting as regards mechanical details. The adoption of high-speed engines in electric power stations made it necessary to install independent condensing plant, generally in the form of a central installation, and with this came the necessity of giving separate guarantees causing more attention to be given to improving the design and efficiency. The usual plant in a factory consists of an ordinary surface or jet condenser of the parallel flow type; that is, in the case of the jet condenser, which is by far the most common type, the steam enters the condenser and immediately comes into contact with a jet or spray of cold injection water, the condensed steam and cooling water falling together to the bottom of the condenser, from which the mixture is removed by the air pump. In the better designed plants the condenser would be of the counter-current type, that is the steam and water pass through the condenser in opposite directions, the steam being gradually condensed throughout its whole course through the condenser and the water gradually taking up the heat from the steam; thus the two are in longer contact than

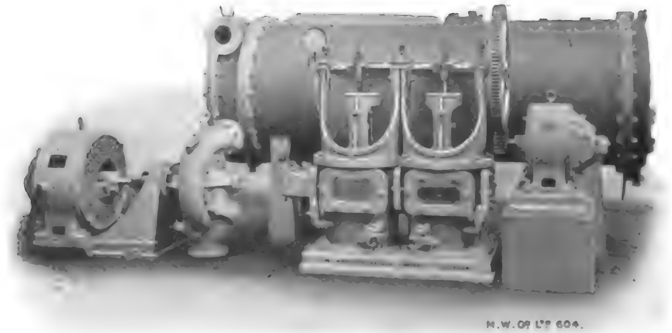


FIG. 1.

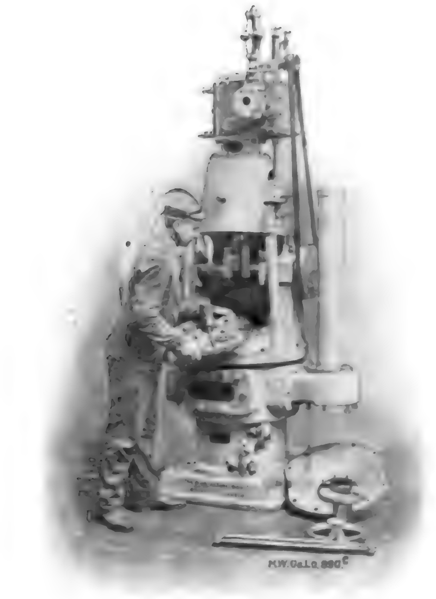


FIG. 2.

with the parallel-flow type and the water leaves the condenser at a temperature almost equal to that corresponding to the vacuum, with the result that a less quantity of water is required to condense the same amount of steam. The same principle holds good in a counter-current surface condenser.

In large installations it is found cheaper and more economical to remove the air and condensed water by separate pumps, but for smaller installations one set of pumps is quite satisfactory.

The Mirrlees Watson Company have made a special study of steam condensing plant, and have supplied a number of installations in connection with factories, some of which are worked entirely independent of the main engines, whilst in others the air pumps are driven directly from the main engines; in either arrangement results are obtained far in advance of what has previously been attained with the ordinary attached plant.

Fig. 1 shows one of the Mirrlees Watson Company's standard independent surface condensing sets with electrically driven pumps; two sets as per this illustration have been fitted to two steam turbines in a new Lancashire cotton mill and give a vacuum within $1\frac{1}{2}$in. (Hg.) of the barometric pressure. The cooling water is circulated through the condenser by means of a motor-driven centrifugal pump; this type of pump has now attained to an efficiency almost equal to a first-class plunger pump, and it has a great advantage in simplicity and very low cost; it also lends itself to being driven direct from the motor spindle instead of requiring a very low speed motor or gear drive, as is the case with the plunger pump. The air pumps for removing the air and condensed water from the condenser consist of a twin set of Mirrlees-Edwards pumps, which have only one set of valves. These being in the delivery plate at the top of the pump barrel, they are easily accessible from inspection doors in the pump body. The whole of the working parts can be easily removed without disturbing the crankshaft. In an ordinary set of pumps these parts can be removed and replaced ready for running in less than three-quarters of an hour. Fig. 2 shows one of the firm's standard steam-driven pumps and well illustrates the feature of accessibility. Fig. 3 shows a similar plant to Fig. 1, but with only one motor; this drives the centrifugal circulating pump direct, and the air pump through single reduction gearing. There is one particular advantage of having the pumps worked independently of the main engine in that the speed of the pumps can be regulated exactly to suit the load on the main engines. There is no doubt that in future more consideration will be given to employing independent condensing plant with mill engines, as keen competition makes it essential to adopt only the most economical of power-plant.

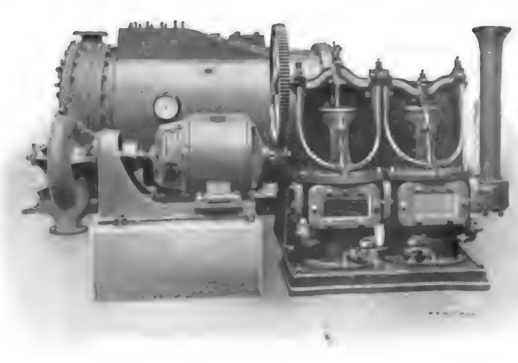


FIG. 3.

General View of Messrs. William McGeoch & Co.'s New Warehouse

A Noteworthy Warehouse.

William McGeoch & Co., Ltd., Glasgow.

Few indeed are the engineering warehouses or showrooms which will compare with the one recently opened in Glasgow by Messrs. Wm. McGeoch & Co., Ltd. Not only is the building artistic and massive as a structure, but internally it is modelled and arranged to give in all departments the highest degree of efficiency.

The architect for the building was Mr. J. J. Burnet, of Glasgow, who is at present carrying out the large extension to the British Museum in London, a contract secured by him entirely on account of work which had already been executed from his designs, and, as will be gathered from the several illustrations, in this instance his reputation cannot have been in any degree lessened by this exercise of his art on the design of an essentially utilitarian industrial warehouse. In its general design the building is at once striking and original in appearance, the detail inclining towards the French Renaissance. It is built of red sandstone, and the two most conspicuous features of the structure are the solidarity and massiveness of both interior and exterior, and the very efficient lighting given to each of the six floors. The construction is fireproof throughout and the departments are centred on separate floors each with its stores and showrooms. The fullest advantage has been taken of lifts, elevators, and telephones for the intercommunication of all departments and for generally facilitating the great amount of business which this enterprising firm is called upon to handle.

From time to time there have appeared in The Electrical Magazine particulars of the electrical specialities manufactured by Messrs. McGeoch. Their products cover a wide range,

The Main Entrance, with Figures representing Science and Industry.

ONE OF THE ELECTRICAL SHOWROOMS.

principally being accessories, such as switches, fittings, hardware, &c. In particular they are large suppliers and manufacturers of the following goods: Incandescent electric lamps, arc lamps, carbons, various kinds of electrical switches, electric-light fittings, and more especially cast-iron fittings which are particularly adaptable for mill purposes. Besides the usual standard types of mill fittings they make, for suspension over the machines, a special dust-proof reflector fitting with glass segment for incandescent lights, also a special switch which is absolutely gas, water, dust, and fool proof, and which reduces to a minimum the chances of fire occurring. These last are specially suited for fixing alongside machines for controlling the circuits to the motors; they are made double, triple, and quadruple pole.

Land and marine work are alike catered for and the apparatus listed covers all industrial, ship and private installation requirements, with a multitude of designs, each and all of which are the right thing for the one purpose. It is undoubtedly this thoroughness in detail which has been the controlling factor in the great development and success of the firm.

At the opening function of the new warehouse some details of the firm's history were given, and they present an interesting record.

The deputy chairman, Mr. Lauchlan A. McGeoch, who presided at the gathering in the absence of the chairman, Mr. William McGeoch, his father, informed those present that it was exactly a hundred years since the founder of the company was born. He also stated that Mr. William McGeoch, sen., the chairman, this year completed fifty years' connection with the business, and that during the long period of seventy-five years since the firm was founded there has only been one removal by death in direct descent.

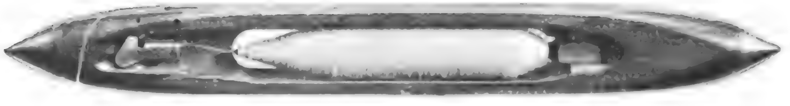
THE DIRECTORS' PRIVATE BOARD ROOM.

This is probably unique in a manufacturing concern, and it is possible that no other firm in the country has such a record. The speaker, Mr. Lauchlan A. McGeoch, and Mr. William McGeoch, jun., he also stated, this year completed twenty years' connection with the business. The former has been most of his time identified with the business in Glasgow, and the latter is responsible for the development of the electrical work in Birmingham. Mr. Alexander McGeoch, the brother of the chairman, takes general charge of the Birmingham works. These gentlemen are all directors of the company, and have as colleagues Mr. William Roxburgh in Glasgow, who more especially is interested in the general hardware departments, and Mr. Robert Archibald, who occupies a similar position in the ship department. The electrical department manager is Mr. D. T. Wilson, who has, along with these gentlemen, been associated with the firm for many years.

The "Amerik" Shuttle.

Wilson Bros. Bobbin Company, Ltd., Liverpool.

THERE have been many attempts made to devise a shuttle which would allow of hand-threading in place of the standard type, which requires suction with the mouth



THE "AMERIK" SHUTTLE.

for drawing the weft through the shuttle eye. The latter type is extremely detrimental to the weaver's health; the constant inhalation of cotton fluff induces chronic chest complaints and consumption, and the front teeth are also destroyed. The trouble in devising a new type to obviate this unhealthy phase of the weaver's work has been to produce a shuttle which could be quickly and readily threaded by hand. Many promising devices have failed because they were too troublesome, and the operative, rather than waste time and patience in handling them, has cast them aside and returned to the old unhealthy form.

The "Amerik" shuttle, of which an illustration is given, has recently been introduced by Messrs. Wilson Bros. Bobbin Company, Ltd., and bids fair to quickly establish itself as a solution to the problem. The threading process is simple, certain, and speedy. The thread is drawn over a curved piece which directs it behind a slightly projecting wire hook; when in this position the thread is easily drawn through the eye by the finger and thumb.

The shuttle described is not by any means the sole speciality of this well-known company. Their bobbins with patent shields are in very wide use. The Garston works are very extensive and renowned for the thoroughly modern special plants with which they are equipped.

New Catalogues.

Steam Turbine Fans.—MICHAEL PAL & CO., London, S.W.—A descriptive price-list; gives illustrations, dimensions and ratings of steam-driven propeller and centrifugal fans.

Continuous-Current Transformers.—THE CRYPTO ELECTRICAL COMPANY, London, S.E.—Illustrated leaflet giving prices and description of a useful d.c. motor-generator or reducing transformer intended for ignition-battery charging, &c.

Fibre Conduit Picture Book.—THE KEY ENGINEERING COMPANY, LTD., Manchester.—A very interesting and high-class publication describing fully the properties and uses of fibre conduits. The illustrations of installations and tests will appeal with interest to all central station men and others having to do with underground mains.

Electric Capstans.—MONTÉ-CALLOW & CO., Ipswich.—This catalogue gives full particulars of construction and operation of a line of d.c. and a.c. capstans.

Induction Motors.—THE BRITISH THOMSON-HOUSTON COMPANY, LTD.—Pamphlet No. 204 describes and gives technical data of two and three-phase motors. With this pamphlet was also sent a new index to the numerous publications circulated by the company.

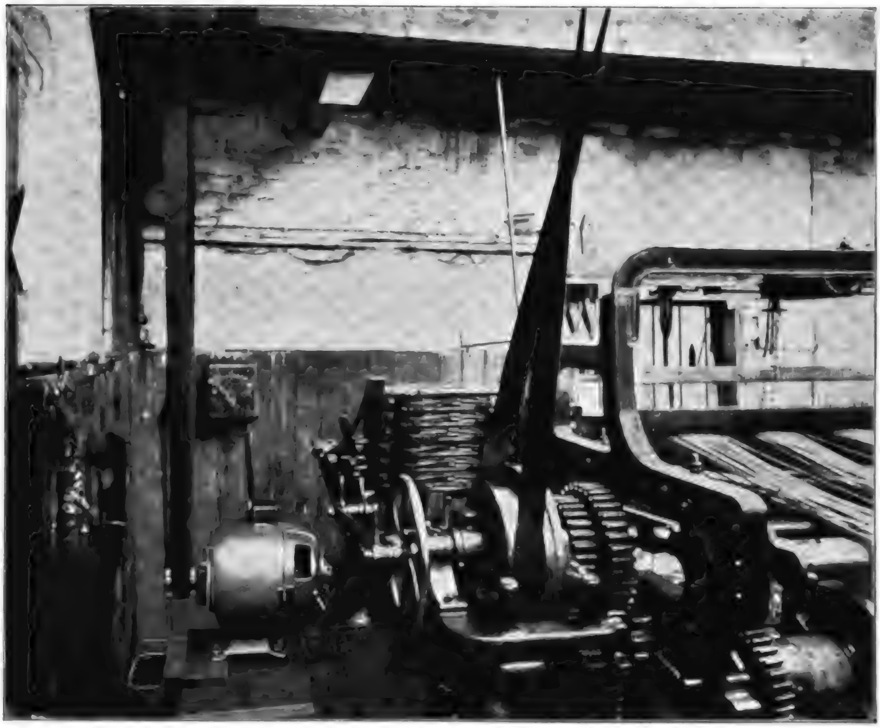
Electric Light Fittings.—THE LONDON ELECTRICAL FITTINGS COMPANY, LTD.—An admirable publication, well bound and giving in convenient size illustrations and prices of a large number of beautiful and effective fittings. This firm also forwards copy of a new price-list of general fittings, accessories and switchboards.

Everything Electrical.—JOHNSON & PHILLIPS, LTD.—Under this title has appeared an extremely high-class publication, which covers by illustration and text the principal specialities of this well-known firm. Printed in two colours and replete with illustrations, it is a fine example of what can be done in the way of technical catalogue work.

Silvertown Instruments.—THE INDIARUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LTD.—List No. 33 is a large, well-produced price-list of Silvertown instruments.

The "Blaze" Flame Lamp.—THE ARMORDUCT MANUFACTURING COMPANY, LTD.—Price-list giving full particulars of a series of flame-type arc lamps, known as the "Blaze" lamps, as for use on d.c. and a.c. circuits.

Generating Sets.—UNION ELECTRIC COMPANY, LTD.—List No. 1006 gives prices, illustrations and descriptions of a line of combined direct-coupled steam-driven generating sets. The list also quotes accessories such as regulators and tachometers.



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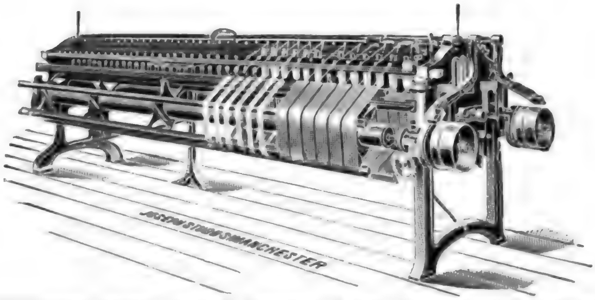

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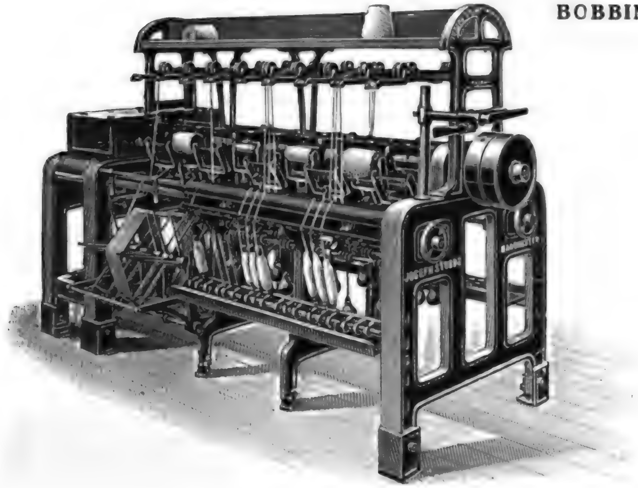

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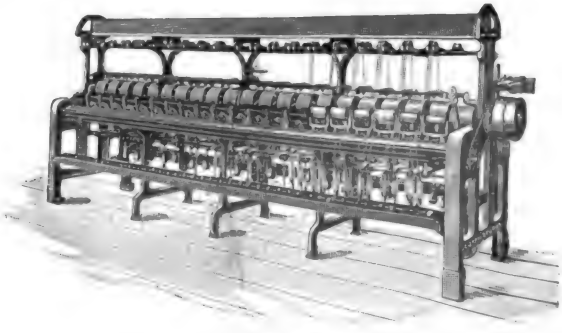

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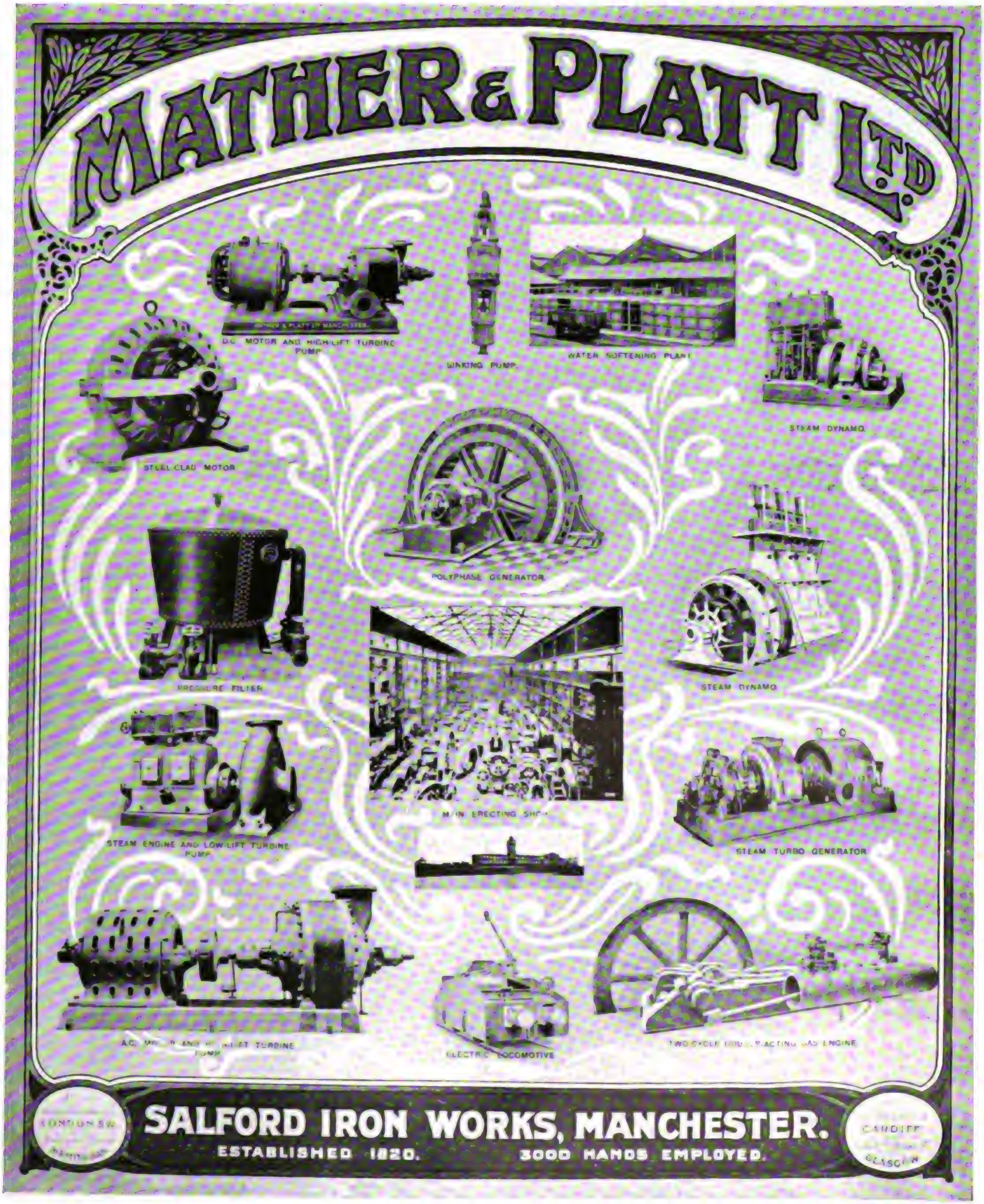
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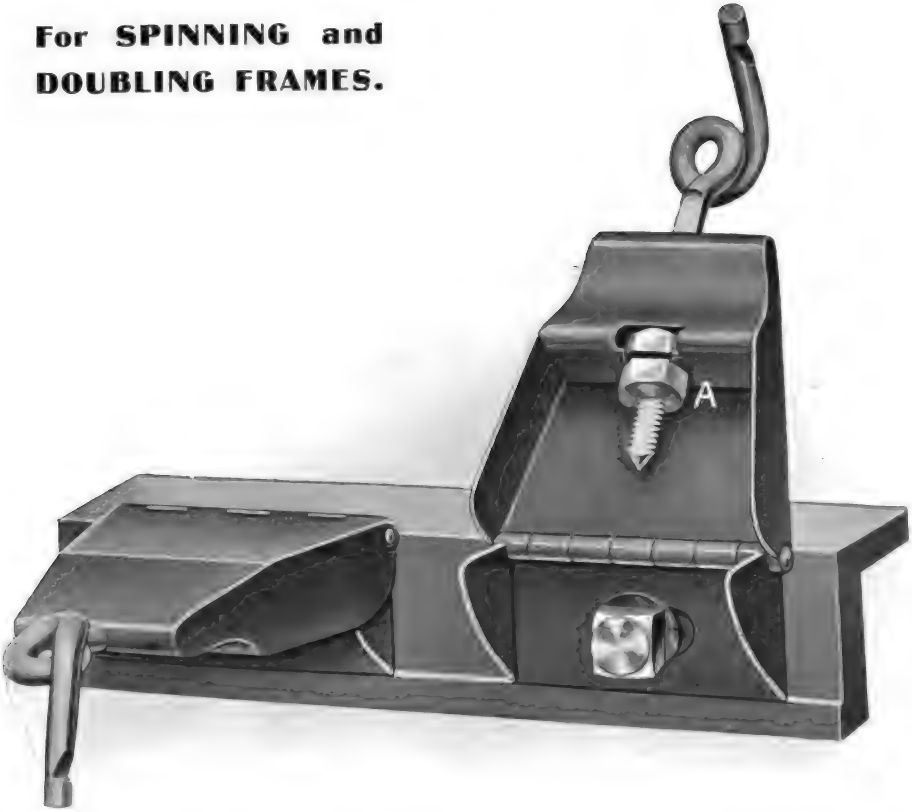

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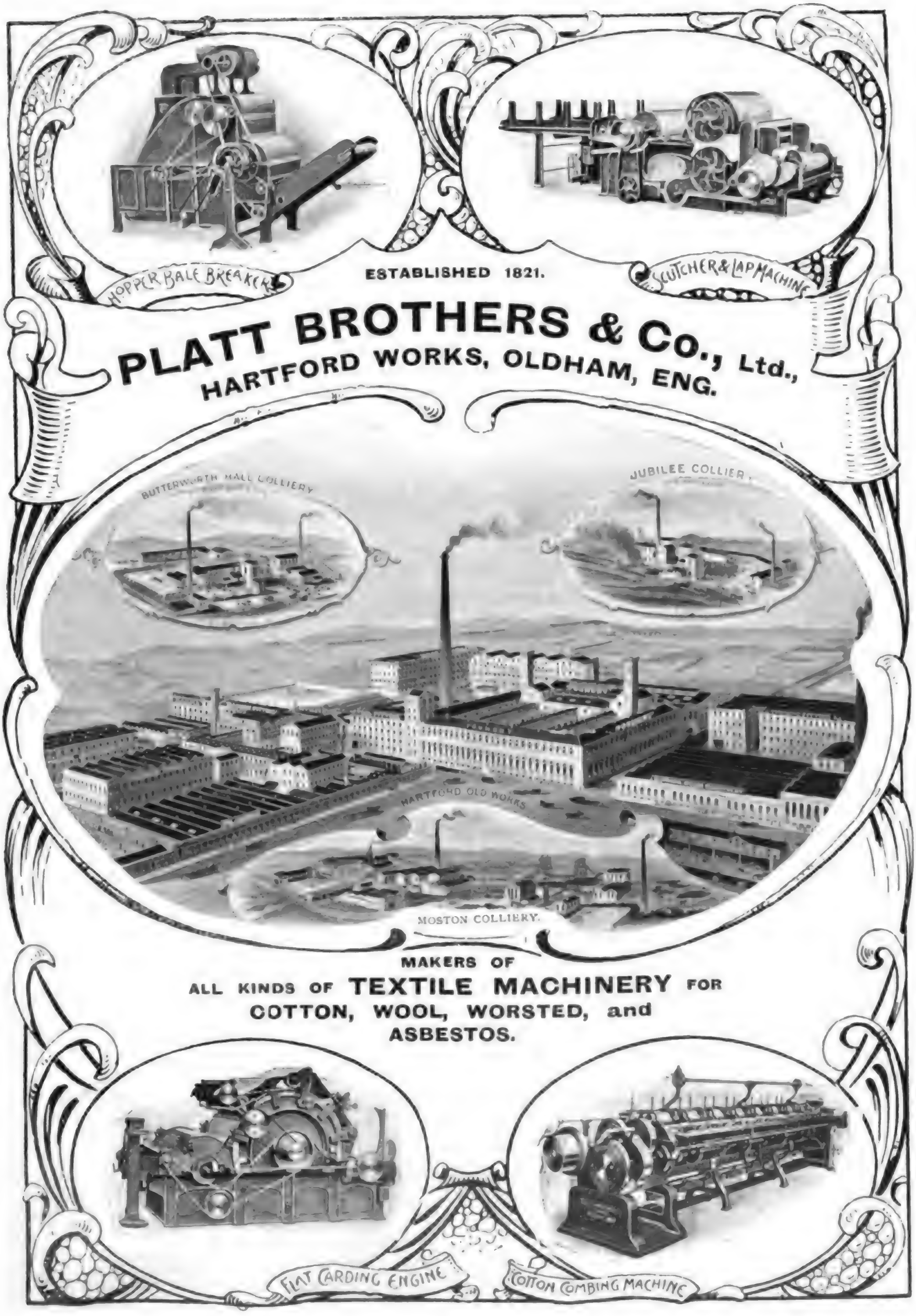
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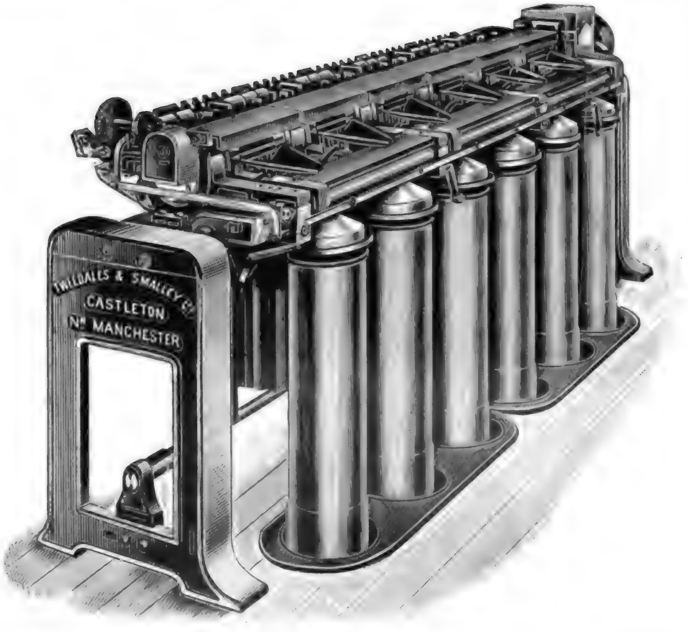

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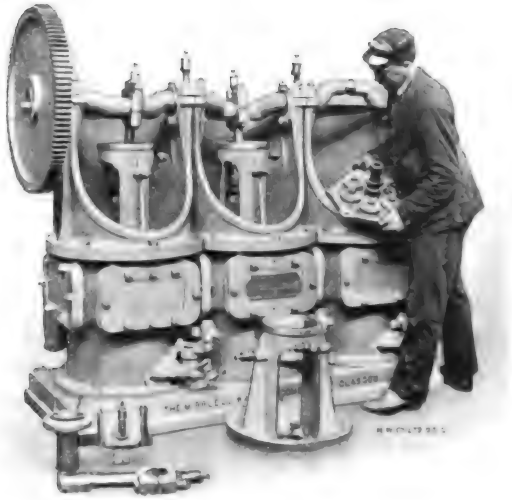
3. Improvements in Drawing Frames for Fibrous Materials. No. 20192. 1893.
4. Improvements in Electric Stop-Motion Drawing Frames for Fibrous Materials. No. 20432. 1893.
5. Improved Mode of Mounting Weights. No. 1098. 1894.
6. Improved Electric Stop-Motion. No. 14511. 1894.
7. Improvements in Electric Stop-Motion. No. 8553. 1904.
8. Improvements in Electric Stop-Motion. No. 2529. 1905.
9. Improvements in Cap Bars for Drawing Frames. No. 17378. 1907.



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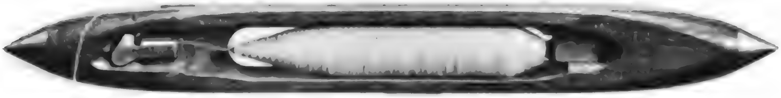

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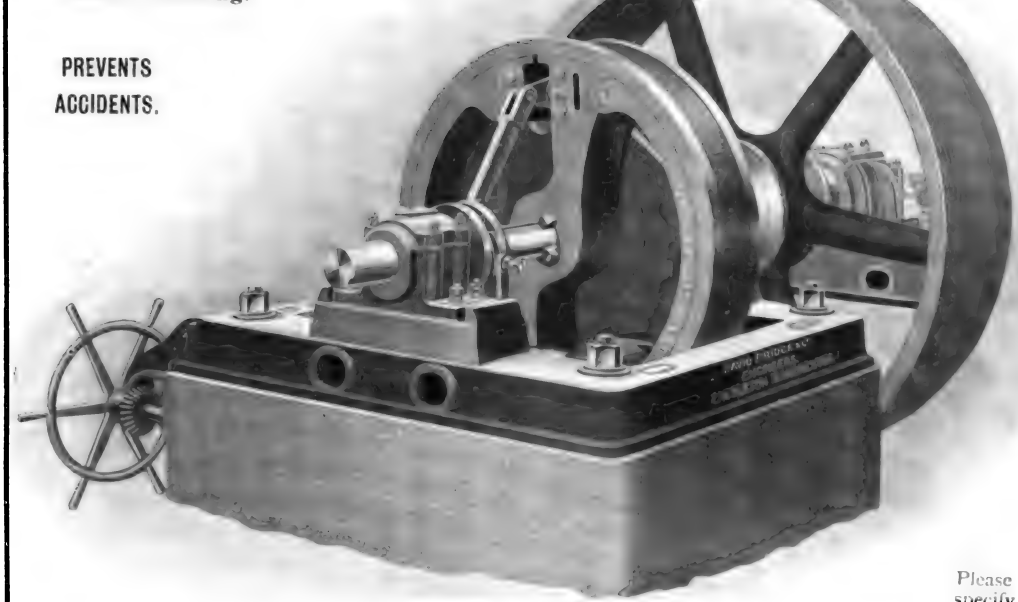

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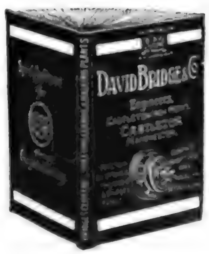

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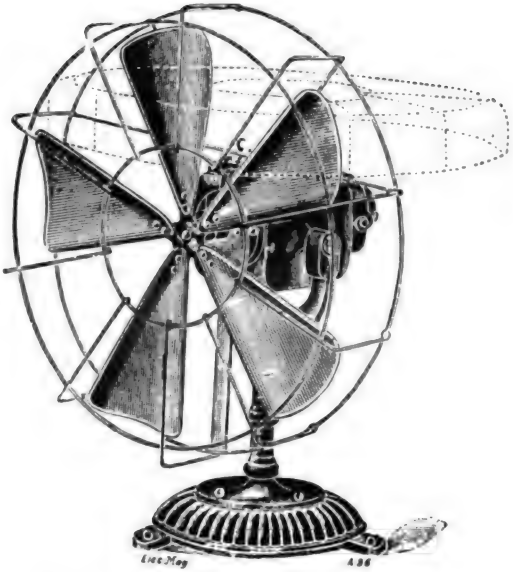

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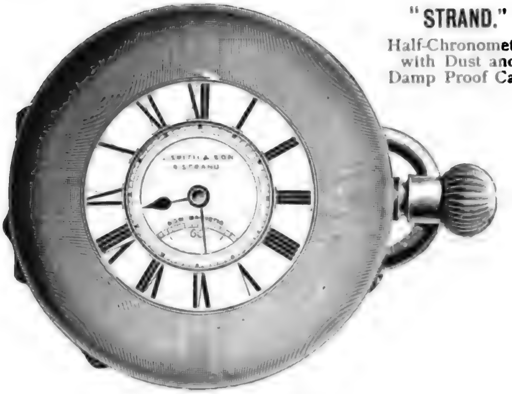

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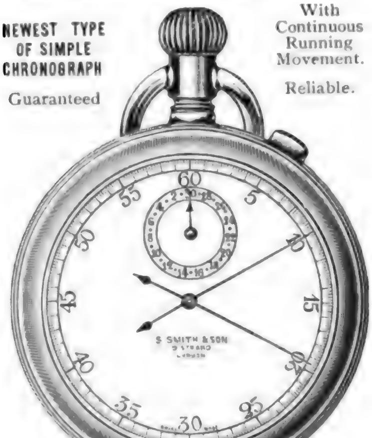

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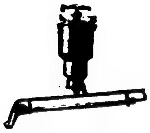

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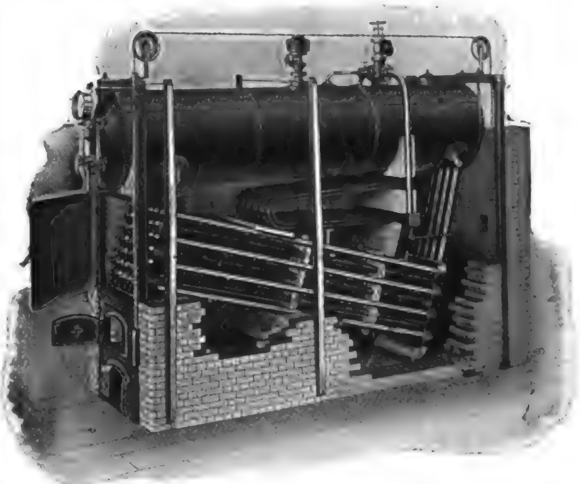

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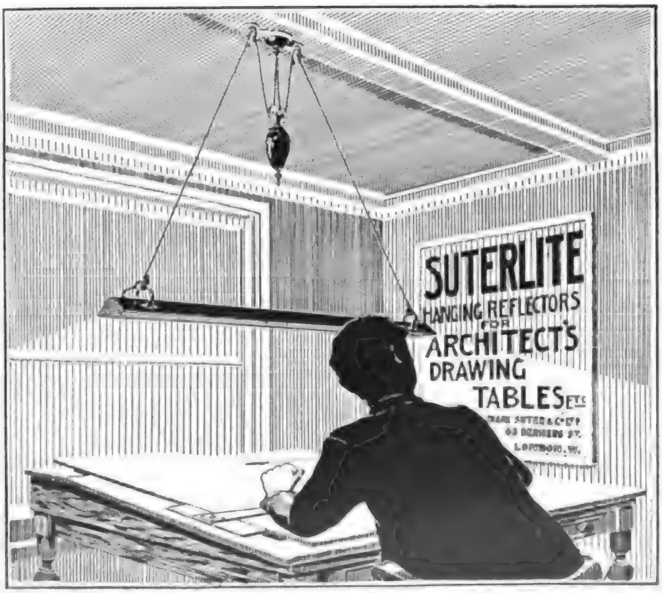

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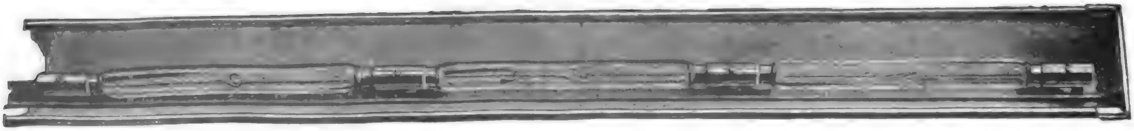


(44th Issue.)

The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. VIII. No. 2. LONDON. AUGUST 30th, 1907.

The World's Electric Progress.

Exhibition Hints. THE nineteenth of next month will see the opening of the International Engineering and Machinery Exhibition at Olympia, London. The large number and variety of firms already entered as exhibitors tells of a real success in store. Last year's forerunner was not by any means so fully supported by British firms, and, largely as a consequence, was not nearly so representative of the illimitable field indicated by its title as it should have been. But it is important to remember that those firms who had then the foresight to see the possibilities of the exhibition and who followed the business-promoting scheme thoroughly, reaped grand returns in the very material form of orders. As a natural result the laggards are coming forward, and the pending exhibition will present a much larger and more comprehensive collection of engineering productions and materials.

At the time of writing upwards of two hundred firms have secured space, and the exhibits will occupy the whole of the great hall, with an overflow taking up a large portion of the annex. The exhibition will be at least twenty-five per cent. larger than that of last year. A feature of particular interest has been introduced in the form of a patent section, in which exhibits of models and designs of machinery and appliances, of such recent origin that they are not yet at marketable maturity, will be classified. There will also be a valuable series of lectures delivered by leading experts during the run of the exhibition, and many other features introduced for the entertainment of visitors.

We have said that orders were the rule at last year's exhibition, when the exhibiting firm seized the opportunity and handled matters thoroughly. It is this latter phase which is all-important. We feel quite safe in saying that it is the neglect of a firm to support its exhibit by special effort and outlay which solely accounts for its failure to secure a large amount of business as a direct result of its entrance into a trade exhibition.

It will not be out of place to emphasize here some few hints for the exhibitor, in the pursuance of which, our experience teaches, he is certain to reap benefit. In entering an exhibit, comparison with rivals is solicited, and this is so readily available that competition is at once the predominating feature of exhibition business. To the exhibitor we say therefore, in the beginning, See to it that your stand is attractive. You have first got to *attract* your prospective client and afterwards to *convince* him.

Dealing with the former there are the considerations of site of stand and form of stand. The one should be prominent and perhaps even slightly intrusive; everybody cannot occupy the imposing, aggressive corner which greets the visitor's entrance, but you can avoid being placed in the most remote recess. As to the form of stand, let this be artistic and substantial in its general design and fitments, not a counterpart of that of your neighbour, nor yet looking mean and tawdry by comparison with his. However, the position and type of the stand itself are secondary to the treatment of the machines or apparatus shown thereon. There

is no sense in showing a gold-plated "exhibition" motor or engine; the buyer knows well enough that white-lead filling, gilt lines and carriage varnish may cover a multitude of foundry sins; put your machines on show in the perfectly clean, smooth condition which you can claim is the finish of the standard article as it always leaves your shops. To the visitor who has notions of buying this is the straightforward way of getting his confidence. Embellish your stand as you like with posters, flash-lights, or other eye-catching novelties, but let your machines be machines and not exhibition dummies. If possible show your machinery in actual motion or even in full work. There are other sure ways of attracting the visitor; one of these you cannot in any case afford to neglect. Press articles and advertisements, the more frequent and prominent the better, must constantly bring your name and show to public notice. You must realise that by this means there are likely customers enticed to the exhibition to see your particular exhibit, and moreover there is the permanent record of your enterprise planted for a future harvest when the exhibition itself has become a matter of memory. A further, but not always certain means of gaining attraction is the distribution of some souvenir novelty. Naturally in this case everything depends upon the form of the novelty and its cost; if you can evolve a really genuine and reasonably cheap device of this kind, don't hesitate to use it.

Having attracted your prospective customer there is still the difficult task before you of convincing him that you are the right firm with the right machine for him. In this we must warn you against the very common practice of leaving your stall in charge of an unskilled junior, or, what is often worse still, to the care of a work-when-he-likes individual engaged just for the run of the exhibition. No one but your best commercial engineer is good enough for exhibition work. He will not let a likely customer pass away uninterested for lack of information or courtesy. How very often it occurs that, seeing some promising article displayed, one's request for information is answered by a shoal of handbills and reference to "our head office." This is merely one phase of that secrecy which is so fatal to exhibition business. There should be no semblance of hidden mysteries of machine or firm when dealing with any enquiry and particularly with that of the exhibition visitor, who has, often as not, come to the show from some far-off district or country on purpose to open an account and who has probably never before had the opportunity of meeting you hand-to-hand and never will seek to again. Put your best man in charge of your exhibit.

There is further necessity in having the clerical work of the exhibit systematized. All leaflets, catalogues and lists must be in the right place and handed the right one at the proper time to the enquirer; records of enquiries and business done or promising must be fully posted, correspondence attended to promptly, and so on. The benefit of this system will be realised when the exhibition is closed and there remains to the exhibitor a goodly list of likely customers to be kept in constant touch with, and arising therefrom an ever-increasing sales record.

Keep your exhibit open all day long from the opening day to the closing day. Visitors often cannot suit your convenience; they take an exhibition *en tour*, and if you miss them once they are most likely gone for all time.

Remember that the exhibition visitor is largely on holiday bent; he combines business with pleasure—see that you don't spoil the combination. As a parting word of advice: the man round the corner is either doing as we suggest or carrying out the spirit of these hints; he is having a happy time, and his order book tells why—don't forget that.

The "Slackness" of the British Manufacturer. WE are again prompted to remind the British manufacturer of his sins of omission and general lack of enterprise in the development of his trade in foreign markets. He may even consider it a little hard that we should return immediately to a subject which is, to say the least, unpleasant. But although a consideration of our general trade methods from this aspect may not be self-satisfying, such matters cannot be lightly passed over; they are, as everyone must know, of vital moment in the welfare of this country and the British Empire. To achieve any good result and imbue the manufacturer with a full sense of his shortcomings takes time—very much time—and that spent in constantly and persistently keeping the facts under his notice. This we have set ourselves to do, and whilst we do not necessarily mean to hammer away or

scold month by month to the point of destroying the reader's interest, we must return to the matter again now if only because of the following communication received a few days ago from Messrs. J. C. Lyell & Co., Ltd., a firm of engineers who have established business houses in London, Manchester, Faversham, Perth, W.A., Brisbane, Wellington, N.Z., Durban, Cape Town, and Bombay. We reproduce Messrs. Lyell's letter in full and can leave it to tell its own story.

"*We were recently appointed sole buyers for machinery, material, boiler plates, tools, office fittings, &c., for one of the largest shipbuilding and general engineering firms in Italy, and a notice to this effect was put into almost every engineering paper, asking firms desirous of doing business to send on catalogues.*

"*We are naturally most anxious to do all we can to increase British trade, but are handicapped by the fact that only four firms had the enterprise to do this.*

"*Is it surprising under such circumstances that the British manufacturer finds himself cut out by the more astute American or Continental rival, and complains of bad trade and bad times?*"

We have also received a further letter from Messrs. Lyell in reference to the serious outlook of British engineering trade development. In the course of this second letter our correspondents record that—

"*On several occasions when shipping goods abroad we have had to buy from America or the Continent owing to their more prompt and up-to-date way of quoting and guaranteeing delivery.*

"*It is undoubtedly this 'slackness' on the part of British manufacturers that is gradually causing them to be left in the background even in our own colonies.*"

Illuminating Engineering.

THE remarkable growth of the new profession, that known as "illuminating engineering," was exhibited to advantage on the occasion of the first annual convention of the Illuminating Engineering Society recently held in Boston, U.S.A. It seems that there are already upwards of 1000 members of the society, and that the muster of members and friends at the convention totalled no fewer than 200. Considering that the society came into being only about eighteen months ago, the progress made affords striking testimony to the value of the specific study and practice of illumination. It has long been acknowledged that with electricity, gas, or any other means of lighting, the obviously faulty and inefficient installation is all too common. In fact, it may be said that only in exceptional cases were the size and disposition of the light centres, the form of lighting and the other factors going to make up an artificial lighting scheme, so proportioned or selected as to give the best result effectively and economically. The numerous papers which have been read before the Illuminating Engineering Society form an altogether valuable and unique series. They reveal the immensity of the neglect of all lighting engineers and contractors. Whilst the society and its transactions are not interested solely in electric lighting, but include all and every kind of illumination, there is naturally a very large proportion of the electrical element in its composition and doings. The net result of the several papers presented on the scientific design of electric lighting installations is to prove that in this department alone there is room for very great practical improvement and operating economies. We have from the beginning encouraged readers to give the study of the principles of illumination their serious attention, and from time to time we have indicated how in making a speciality of lighting effects and means, electrical workers, who might otherwise be confined to the rut of ordinary artisan work, have a certain and profitable new field of labour opened to them.

POWER: and its application to INDUSTRY

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Electric Cableways.

JOHN M. HENDERSON.

THE following particulars are abstracted from a paper entitled "Cableways used on Shipbuilding Berths," read at the Aberdeen meeting of the Institution of Mechanical Engineers last month. The systems described are installed at Messrs. Palmer's Shipbuilding and Iron Company's works, Jarrow-on-Tyne, where three berths are fitted with the apparatus.

The conditions at Jarrow are generally similar to those in other large shipbuilding yards, and the suggestion that a system of overhead cables and trolleys might be applied to shipbuilding berths was made in the form of an enquiry from Messrs. Palmer's Company. Broadly the problem was (1) to suspend the steel cables 100ft. or more above the ground in such a way that a useful load of several tons could be handled; (2) to provide for moving the load transversely, in addition to raising and lowering and running it from end to end of the berth; (3) to place the operator where he would have the best view, and therefore the most efficient command of his work. It was also stipulated that electricity should be the motive power.

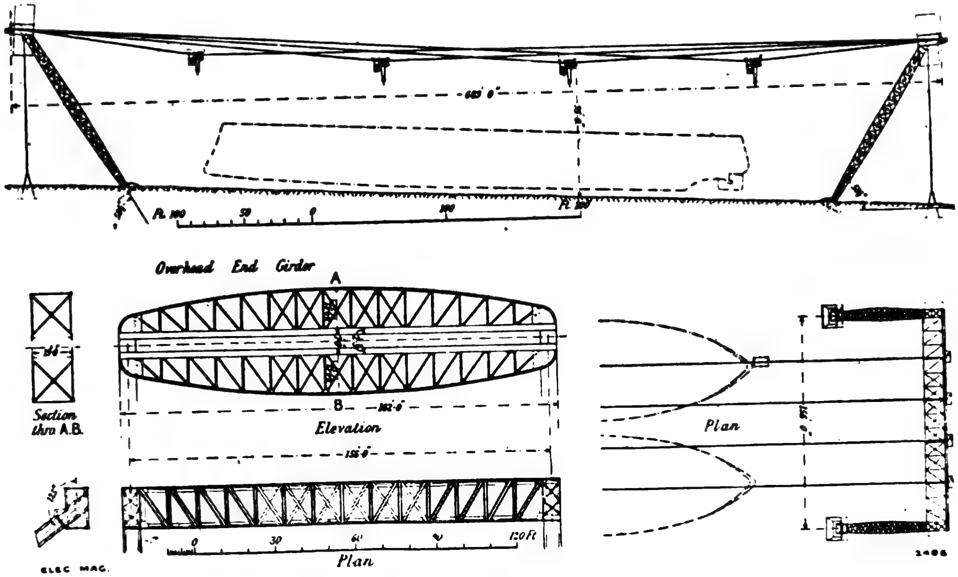


FIG. 1. GENERAL ARRANGEMENT OF THE CABLEWAY.

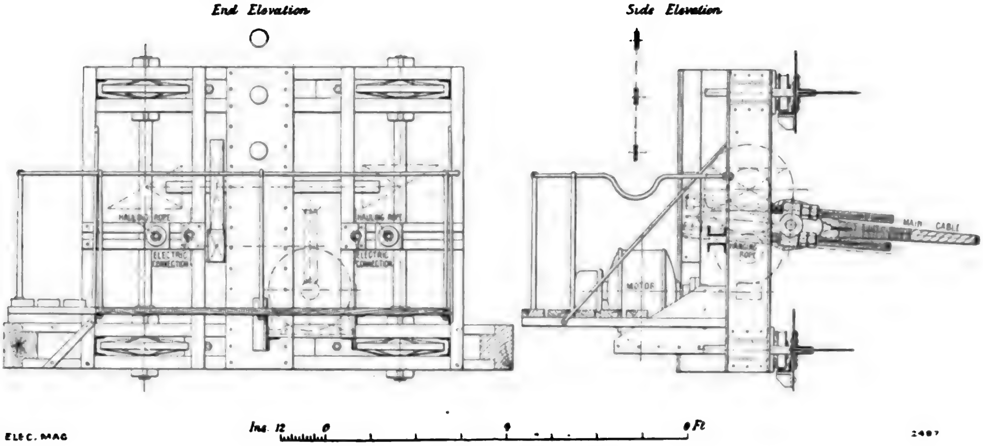


FIG. 2. DETAILS OF END CARRIAGE.

The first berth to be covered is a rectangle 500ft. long and 100ft. wide; the second and third berths are 700ft. long and are each 75ft. wide. Fig. 1 shows the second gear, which, except that it is larger, has four load-handling units instead of three as in the other, and in certain details is like the first one.

The pillars at both ends of the berths rest on strong concrete seats. The pillars are made of steel, lattice construction, and are rectangular in cross-section. The corners are of stout angles and plates with angle and flat bar bracing on all four sides. There is a short length of plating all round at both extremities. As will be seen, the pillars are inclined outwards, that is, from their base away from the berth. Vertical supporting pillars were not practicable; guys could not be fixed in the fairway of the River Tyne nor in the High Street of Jarrow. Neither were vertical pillars with buttresses considered to be satisfactory both on account of excessive cost and the ground space which would be occupied by the props and their foundations.

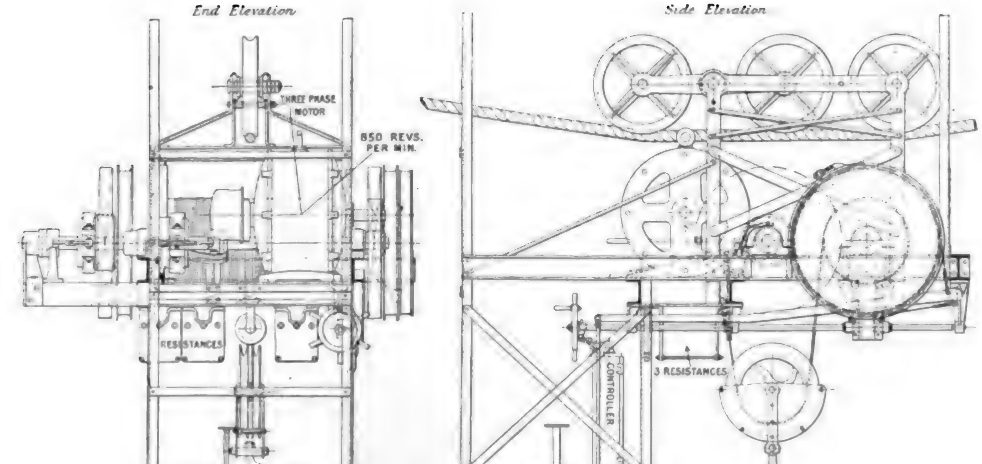


FIG. 3. DETAILS OF LOAD CARRIAGE OR TROLLEY.

FIG. 4. VIEW OF LOAD CARRIAGE.

The cross-girders of the larger installation are as shown on Fig. 1. For convenience in erection the end girders were, in the case of both gears, made in two parts—an upper and a lower; they are built of steel sections, plates and bars, and are of suitable strength to resist the strain due to the weight and tension of the four cables and of that due to the weight of the load-carriages with their load. The upper and lower halves of the girders are securely bolted to the head of each pair of supports, and to prevent them deflecting horizontally vertical bow stiffening is provided. There is a clear space between the upper and lower portions of the girder to allow of the transverse movement and vertical play of the cables and attachments. While the outward inclination of the pillars, with the weight of cross-girders and end-carriages, help towards balancing the weight and tension on cables and the weight of load-carriages, the structures are firmly guyed at each corner to a solid concrete block. The four steel-rope guys drop vertically from the head of the column to which they are attached to the anchorage, suitable means for adjustment being provided in each. The anchorages at the river end are well out on the foreshore and at the upper end are put belowground, leaving only the vertical wires as an obstruction. There are also two steel-rope stays, one at each side, connecting the heads of the upper and lower pillars on the port and starboard sides of the berth, so that, although practically in equilibrium, the structures of the cableways are secured by those stays and guys so as to be free of any movement.

Both ends of each main cable are attached to a carriage which travels on rails fixed on the outer side of the upper and lower girders. The end-carriages are as shown in Fig. 2; they are made of a steel framing and are carried on four rail wheels. The four wheels are driven by an enclosed reversible motor of 12b.h.p. geared through worm and spur gear to the two axles on which the wheels are keyed. The motor on both end-carriages of each cableway is controlled simultaneously by the operator on the load-carriage from any point along the cable.

The load-carriages or trolleys on the second gear are shown in Figs. 3 and 4. They are also of steel framing with a suitable cage for accommodating the operator, and

covered in with an awning carried on wrought-iron stanchions. Each of the carriages carries a 35b.h.p. enclosed reversible motor, from which power for both the hoisting and travelling motions is derived. The longitudinal movement of the carriage is obtained through friction and spur gearing from the electric motor to a travelling motion shaft on which two rope drums are keyed, one at each end. Two wire ropes are stretched from end to end of each cableway, each of the ropes being wound on its drum a sufficient number of times to prevent slip in the opposite direction to that in which the carriage is travelling. The hoisting motion is obtained through friction and spur-gearing to a drum running loose on a hollow steel shaft. The load is lifted through four parts of wire-rope and hoisting block, the purchase being doubled by the block. Mechanical friction foot-brakes are fitted to both longitudinal travelling and lowering motions, the operating levers being conveniently arranged in the cage.

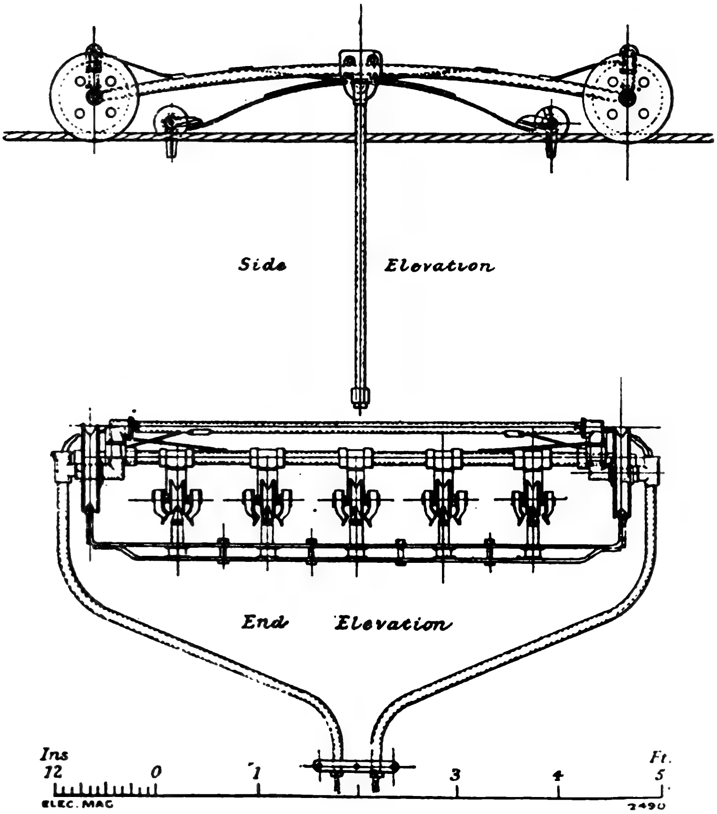


FIG. 5. CURRENT-COLLECTING GEAR.

The speeds are: of longitudinal travel about 500ft. per minute; hoisting 3 tons, 100ft. per minute, and lighter loads at somewhat higher speeds. The speed of cross travelling is 25ft. per minute or thereby.

The gradient of the main cables, irrespective of sag, is the same as that of the ground. In a length of 700ft. the sag is about 22ft., and in cases like that at Jarrow, where all materials are brought to the end of the berth, the load descends by its own weight, after being hoisted to the required position over the structure of the vessel. The return journey of the carriage is made when it is light, thus minimising the power required. In such an outfit the importance of the main cables makes it imperative that great consideration should be given to them. The wire of which they are composed was specially drawn, and has a tensile breaking strain of 75 to 80 tons per square inch, with an elongation of 20 per cent. in a length of 8in.

Special collecting gear and connections are provided on each load-carriage, and the chief point of difference between the first and second installations lies in the arrangement of the bare conductors for supplying energy to the load-carriage motor and control of the end-carriages. On the first cableway they are arranged in a vertical plane, and six wires are used in two sets of three on each side of the load-carriage, these being stretched as tightly as possible between the two end-carriages. The collectors on the load-carriage are of the sliding-contact type, and rigidly attached to each side of it. It was thought that this method could be improved upon, as there is a certain amount of trouble in keeping the

sag of copper wires to correspond with that of the others. In the second installation the wires have accordingly been arranged in a horizontal plane, and their number reduced to five. There are in addition two supporting steel ropes at each side. The supporting cables are spaced apart by steel distance-pieces, into the upper side of which insulator bolts of tramway pattern are fixed to carry the ears for holding the trolley wires. The distance-pieces are spaced at 85ft. centres, and give a particularly rigid construction to the conducting wires. The arrangement is illustrated by Fig. 5. On the upper surface of the wires a bogie is placed which is provided with wheels for running on the supporting cables, and also for making contact with the trolley wires. Separate flexible cables are brought down from this bogie to the load-carriage, but the pull on the bogie is taken up by separate steel cable-connections between it and the load-carriage. This arrangement has been found to answer admirably in all conditions of weather. The bogie and control wires can be reached from the roof of the load-carriage, a special platform being provided for this purpose. In the No. 2 cableway the wires are fed from a four-way distribution board on one of the bridges, four three-core flexible cables connecting the board with the trolley wires. The distribution board is fitted with four three-phase overload circuit-breakers, one for each load cable, and the board itself is supplied with energy by a three-core cable leading up one of the legs. The reduction in the number of trolley wires from six to five has been possible because the reversing of the end-carriage motors is effected by reversing two of the phases, the remaining phase being supplied by a conductor common to all the motors. The motors are all of the enclosed type, designed to suit the generating plant of the yard, which is three-phase alternating current, voltage 440, with a periodicity of 30 per second.

With regard to the working and upkeep of cableways, no special expenditure has been necessary so far; certainly not more than would have been required for an outfit of jib-derricks. The main cables, as well as the running and hoisting wire-ropes, are kept saturated with oil; and in regard to wear and tear, it is estimated that the main cables, if kept in fairly constant use, will have a life of about six years. The cost of renewal per cable for the smaller gear would be about £95, and for the larger gear about £150. The steel structures were coated, after being built, with linseed oil and painted at the time of erection. The cost of repainting both is estimated at £95 to £100, and it is intended to do this about every second year.

As to the general utility of the system, experience has proved its excellence; indeed, some features, which before the first gear was put into operation gave some anxiety, have since been found of benefit. For instance, it was thought that a load suspended on a wire of 500ft. in length would have a tendency to surge vertically, and might make it difficult to place plates in the exact position required. In actual practice this fear was soon dispelled; as a matter of fact, it is found to be a distinct advantage to have the plate or piece of material, while being lowered into position,

—	Dimensions of Berths.		Clearance under Hook at Centre of Span.	Number of Hoisting Units.	Motors.	
	Length.	Breadth.			On End-Carriages.	On Load-Carriages.
	Feet.	Feet.	Feet.		B.H.P.	B.H.P.
1st gear	500	100	80	3	12	35
2nd gear	700	150	85	4	12	35

—	Circumference of Main Cables.	Breaking Strain of Main Cables.	Quantity of Material used in Structures.	Circumference of Steel-rope Side-stays.	Circumference of Anchor Ropes.
	Inches.	Tons.	Tons.	Inches.	Inches.
1st gear	7¾	175	278	5½	6¼
2nd gear	8¼	200	456	8½	7

suspended in a more or less elastic fashion, as is the case in a cableway. Take, for instance, a shell plate; it is only necessary to bring the plate to within an inch or two of its position, and the end of a spanner passed through a hole in the plate and the corresponding hole in the frame pinches it into place; whereas, in the case of a rigid crane, the plate would have to be manœuvred into its exact position by the crane-man. Another point which gave some concern before the gear was operated was whether, when a load was suspended, say, towards one end of a cableway, and it was found necessary to move it transversely, the two end-carriages would move in unison. This, after adjustment of the motor resistances in the end-carriages, has been quite satisfactory, no trouble in this direction ever arising.

With regard to the cost of such an installation compared with that of other systems, without going into figures, the author stated that the cheapest arrangement of a fixed structure with cranes overhead would cost double that of the cableway, and in many instances four times as much would be nearer the mark; besides which, where the trolleys cannot be moved sidewise, but must travel always in the same line as in fixed structures, more trolleys are required, and hence increase the cost of working and upkeep. Any comparison with cantilever cranes as to cost would be enormously in favour of the cableway, while as to utility there is no comparison possible, the cantilever crane being, in the author's opinion, the most unsuitable of any device for ship construction. Time for erection (another important matter) is again greatly in favour of the cableway, as a berth can be dealt with in from three to four months with a minimum of interference with the progress of work on vessels under construction; indeed, several berths might quite well be installed in the same time.

Particulars of both equipments of cableways are contained in the table on the preceding page.

In conclusion, the author expressed his indebtedness to Mr. J. L. Twaddell, shipyard manager of Messrs. Palmer's Shipbuilding and Iron Company, of Jarrow, and to Mr. R. J. Webster, of the same firm, for information and photographs which they kindly put at his disposal regarding the patent devices described.

Windmills as Prime Movers.

CAREFUL prony-brake tests show that in a 25-mile wind, which is better than the average, a wheel 8ft. in diameter gave in useful work, pumping water, 0.12h.p., while a wheel 12ft. in diameter developed 0.64h.p., and these figures are the best for the sizes shown out of over fifty tests of almost as many makes.

It is not likely that any locality will average more than 5 days or 120 hours a month in which the wind exceeds 20 miles per hour. To arrive at an average, then, calculations should be based on what the mill will do on a 20-mile wind. Following are the results in detail from the most powerful mill tested, which had a wheel 30ft. in diameter; lift to tank 135ft.:—

Velocity of Wind Miles.	Gallons Pumped.	Horse-power.
8	6.7	0.23
12	16.9	0.58
16	22.5	0.77
20	27.0	0.92
25	31.5	1.07

The cost of repairs to the mill and pump is reported as being between £10 and £12 per annum.

To take another view of it, a calculation of service of a 16ft. windmill averaged 488h.p.-hours per month over a period of one year. By the time the water elevated by these 488h.p.-hours had gone its way through the proposed hydro-electric generator there would probably not be more than 300h.p.-hours left for the average month.—A. M. Orr in *Power*.

Tests of Oils.

IT is, of course, a task for the chemist to analyse the various oils brought into power plant service with a view toward determining the specifications best adapted to the situation in each station, and insuring the fulfilment of these specifications. At the same time, there are a few simple tests which can be made without an extensive laboratory to determine a good cylinder, engine, or dynamo oil. Some of these tests were recently published by the National

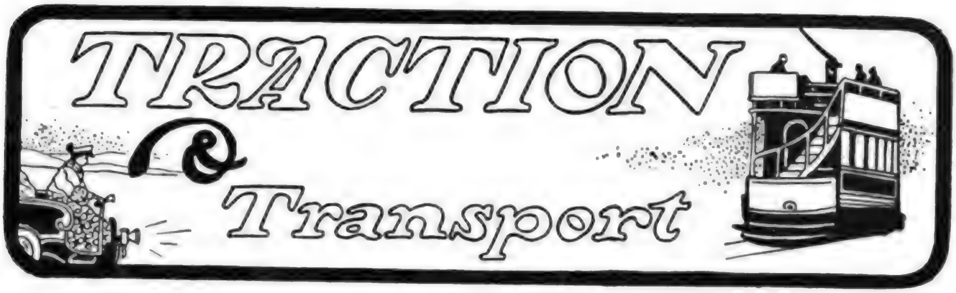
Electric Light Association (U.S.A.). For either engine or cylinder service a good oil should have body enough or sufficient viscosity to prevent the surfaces to which it is applied from coming into actual contact. Perhaps this is the most important qualification of good oil, and with a careful viscosity test a good oil will not be rejected or a poor oil accepted. Viscosity is closely related to the density of an oil. The simplest means of determining the viscosity of an oil is to test the time of flow of a certain volume of oil through a small orifice as compared with the time of flow of the same volume of good oil or water. The oils and water compared must be tested at the same temperatures, and preferably at the temperature to which the oil is to be subjected. A copper or glass vessel with an orifice of about one-sixteenth of an inch in the bottom is satisfactory, except where very large quantities of oil are used. In the latter event the purchase of a viscosimeter will doubtless pay the company. Accurate tests of the viscosities of oil as compared with water have given the following results: Prime lard oil, 3.6; sperm oil, 2.2; castor oil, 2.6; rape seed, 4.2; the temperature in these tests being 68deg. F.

Freedom from corrosive acids, the maximum fluidity possible with the required viscosity, a minimum coefficient of friction, high flash and burning points and freedom from elements liable to produce oxidation or gumming, are all desirable features of oil for power plant service. To identify an animal oil or a vegetable oil, chlorine gas may be applied. The former is turned brown and the latter white by its action, and if there is no opportunity for further chemical tests this method of attack will often serve the purpose in a rough way, though it throws no more light upon the composition of the oil than a calorimeter test of coal exhibits the constituents of a fuel sample.

The flash and burning tests may be readily made by placing a sample of the oil in a small receptacle having a tight cover through which a thermometer can be inserted. A small hole is essential in the cover to allow the vapours to escape as the oil is heated. The vessel should be gently and slowly heated through a layer of sand, and when the oil is hot a lighted match or an incandescent wire may be passed over the hole to observe the temperature at which the oil flashes. The burning point is obtained by continuing the heating and noting the last temperature observed at the time the oil takes fire. The gumming and oxidation characteristics may be obtained by noting the time required for a small amount of oil to flow down a smooth inclined plane with the time taken by a like amount of good oil to flow over the same course.

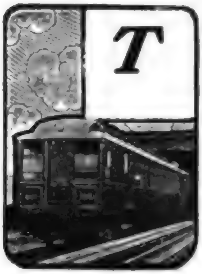
The simplest method of finding the density without the use of instruments is to find the loss of weight of some body in oil and in pure water. The ratio of the loss gives the density as compared with water. Animal oil densities may run from 0.62 to 0.9; sperm oil at 39deg. F. has been found to have a density of 0.88; rapeseed, 0.91; and cotton-seed, 0.92.

Moisture in transformer oil may be detected in several simple ways. By reason of its specific weight moisture in transformer oil will generally be found at the bottom of the case. As most cases for oil shipment, including transformers, are provided with plugs, it is an easy matter to secure a sample from the bottom in a test tube. By providing the latter with a tight cork and bent glass tubes about $\frac{1}{8}$in. in diameter and heating the test tubes, the moisture in the oil will condense in the upper part of the small tube and will be prevented by the bend from falling back into the oil. A second method is the application of a red-hot wire to the oil, a crackling sound following the presence of moisture and simply a puff of smoke if the oil is dry. A simple chemical test consists of driving off the water in a few crystals of copper sulphate by roasting. This leaves a white powder, and when oil is added to this the original blue colour returns if the oil contains moisture. Of course, these tests are approximations, but they are useful in plants where the services of a skilled chemist are not available, which is the case on most electric plants. Needless to say, records of oil consumption and overheated bearings should invariably be made in power plants.



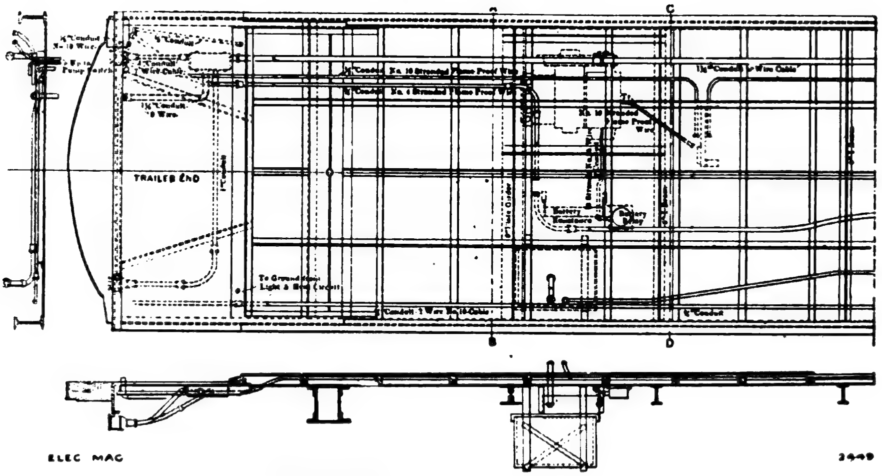
A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

Railway Car Wiring and Piping.

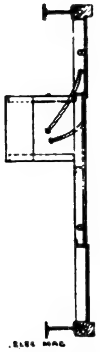


Too frequently the wiring of cars and the disposition of the apparatus under the car receives very little attention. For this reason the practice of the Metropolitan West Side Elevated Railroad, Chicago, in the equipment of fifty cars recently put into service, as described in a recent issue of the *Street Railway Journal*, is of especial interest. In general design and dimensions the new cars are similar to those already in use. However, the designs of the bottom framings of the two types of cars are radically different. The bottom framing of the former car consists of built-up side girders of the fish-belly type, with cross channel bars at the ends and intermediate bridging of I-beams. The wood floors rest directly on this framing. The bottom framing of the new car consists of two parts, a steel sub-framing of I-beams, covered over entirely with a $\frac{3}{16}$in. steel floor, and a wood framing over this consisting of wood side sills and stringers carrying a wood floor. Between the wood floor and the steel plates there is a space of about $1\frac{3}{4}$in. The fish-belly type of side girder was abandoned partly because of its depth, which prevented proper ventilation of the apparatus under the car. With it, to obtain sufficient cooling of the compressed air, radiating coils were hung on the outer side of the girders. In the new car the decreased depth of the side I-beams permitted these radiating coils to be hung under the car. An increased cooling effect on the air in the tanks has been obtained by hanging the tanks below the side I-beams. In fact, they were placed so low that it was not advisable to put the customary drain cocks underneath, so to permit drainage the tanks were hung with one end about 3in. lower than the other, and a drain pipe provided with a globe valve was fitted in the lower end.

All of the air apparatus was located at one end of the car so as to eliminate as much piping as possible. By placing the apparatus of the Westinghouse electro-pneumatic control system at the No. 1 end of the car, the connections between the motors and the reverser and switch group were kept short, and in addition the weight of these heavy parts was thrown on the motor track. All the wiring of the controller under the car, with the exception of two or three cables about 1ft. long, is in loricated conduit. Probably the most unusual feature in connection with the wiring is the fact that all the conduits, except the short ones, are run in the space between the steel plates and wood floor. They were built in during the construction of the car, and are held in position in such a manner that vibration is impossible. Those terminating in the jumper receptacles on the end of the car and those leading to the master controller, drop down through the steel plate just behind the end sills, while those leading to the pump and controller parts are carried through the plate immediately over the apparatus to which they connect. In the illustrations the conduits shown by full lines are those above the steel floor. Those underneath are shown by broken lines. One advantage gained by carrying the conduits in the space above the steel floor is that no brake



Plan and Section of Trailer End of Car.



Section C-D.

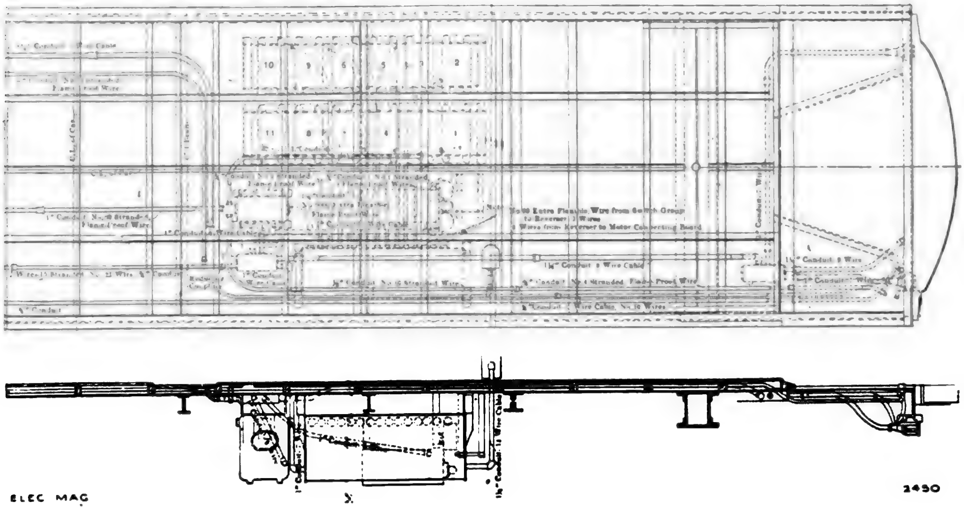
Section A-B.

apparatus and other parts were to be avoided; in addition, they could be run straight with increased economy both in labour of installation and in material. An idea of the relative location of the switch group reverser, grids and main switch may be obtained from the illustrations. By assembling these, all connecting cables were materially shortened. The loricated conduits between the controller apparatus are held in by wrought-iron straps bolted to the steel floor above.

Although assembled compactly, the controller apparatus is so placed that any part of it may be easily reached for inspection or repair. The limit switches are mounted near the ends of the reverser, where they are readily accessible. All the control apparatus, and in fact all the apparatus under the car, is suspended from the steel floor by wrought-iron supports. The rheostats are carried by angle-iron frames, and the supporting bolts for each grid are provided with lock nuts; provision is made also for the insertion of a cotter key underneath the nuts.

Instead of carrying the motor leads up against the car floor to a point near the bolster, as is usually done, the leads are clamped so that they rest on the top of No. 2 motor and drop down under the truck end frame and up to the connection board. This method of bringing out the motor leads, which has been used by the company for two years, avoids making short bends in the cables and also permits the two-way connectors to be placed at a point where they can be got at without difficulty. The connection board referred to consists of a 2in. oak block about 14in. square suspended from the steel flooring above by wrought-iron hangers. At both the forward and rear edges of the board a cleat containing U slots for the seven wires is bolted. In connecting up the motors the two-way connectors are first clamped together and then short pieces of canvas hose are drawn over them. When that cleat nearest the motors has been bolted up the connectors with their hose coverings are held up rigidly against the connection board between the two cleats.

In wiring the cars no cables were soldered except where the wires were held rigidly. In several places soldering was avoided by using Dossert connectors, both of the T and the four-way type. Special effort was made to eliminate wood under the car, none being used except for the connection board and in



PLAN AND SECTION OF LEADING END OF CAR.

the battery boxes. The conduits used varied in size from 1¼in. to ½in. In bending them care was taken to see that the bends were not too short or of such a character as to make it difficult to draw the cables in them. All the cables drawn in the conduits, with the exception of the control circuit cables, are of rubber-covered flame-proof wire.

In locating the apparatus under the car, particular attention was given to distributing the weight with reference to the centre of the car.

All the positions for the apparatus and conduits and the details as to hangings and supports were worked out before the construction of the car. This enabled the holes and openings in the steel work to be made during construction, and as a consequence the installation of the apparatus together with the piping and wiring was very much facilitated and cheapened.

The careful manner in which everything was worked out previous to the installation of the apparatus had a very decided effect on both the cost of the material required to wire the cars and of the labour necessary to install the apparatus and wiring. The average cost on fifty cars was: Material, per car, $85.14; labour, wireman and helpers, $46.77; labour, bending, placing and hanging conduit, $26.75; making a total per car of $158.66.

The cost given for material includes all wires of the car body and trucks except those in the light and heat circuits above the car floor and the small cables of the battery control circuits which were purchased as part of the control apparatus. It includes all conduits, hangers for apparatus and conduits, all conduit fittings and wire connectors.

The amount and sizes of conduits used were: 1¼in., 60ft.; 1in., 104ft.; ¾in., 110ft.; and ½in., 20ft.

The amount and sizes of wire required were: No. 00 stranded flame-proof, 69ft.; No. 00 extra flexible flame-proof, 17ft.; No. 0000 extra flexible flame-proof, 5ft.; No. 1 stranded flame-proof, 96ft.; No. 4 stranded flame-proof, 38ft.; No. 8 stranded flame-proof, 12ft.; and No. 10 stranded flame-proof, 15ft.

The No. 00 stranded flame-proof wire was used between the trolley shoes and the junction near the line switch where the trolleys from each end of the car are brought together, except where flexibility required the use of No. 00 extra flexible flame-proof. The No. 0000 wire was used between the line switch and the junction referred to, and between the line switch and the switch group.

The resistance leads are made of No. 1 stranded flame-proof, and the trolley connections of the light and heat circuits, and to the light and heat terminals on the ends of the cars, are No. 4 stranded flame-proof wire.

The World's Electrical Literature Section contains a classified list of all articles of interest Central Station men. CONSULT IT and save yourself much valuable time.

*Extension of Electricity Supply to Outlying Districts.**

R. L. ACLAND.

THE lighting network of a small town of which the growth was somewhat slow was naturally cut pretty fine on the outskirts, and when a demand arose for a considerable supply in a small compact area some 1½ miles beyond the edge of the existing network, and 2½ miles from the power-house, the question was how to deal with the same in the most all-round economical manner, *i.e.* combining a small capital expenditure with low working costs.

It was considered that the requirements of the district would be supplied for the present by 50kw., and taking this figure as a basis, a comparison of the various systems was made.

High-tension transmission from the power-house 2½ miles distant would have involved rotary converters, static transformers, and special switchgear at either end, with an enlargement of the main power-house at one end, and special buildings at the other, to accommodate the necessary plant, whether the supply given was alternating or direct, in addition to 2½ miles of high-tension cable, half of which would have been drawn into the existing ducts, and the remainder laid solid.

* Abstract of Paper read at the Convention of the Incorporated Municipal Electrical Association, Sheffield. July, 1907.

An extension of the existing low-tension system was out of the question, as the nearest feeding point could not accommodate the load, and it would have been necessary to go right back to the power-house.

An ample area of copper had fortunately been laid with the tramways which extended to the district requiring the supply, and the full length of line provided for was not ultimately constructed. It was, therefore, considered that the best method would be to utilise a portion of this surplus copper, but as the lighting would have to run in parallel with the tramway supply, the question of taking up the variation in voltage at the far end of the traction feeders, was the most important one that had to be settled.

This could be done in one of two ways, either by putting down a battery of accumulators and charging same by a motor generator during the day and discharging at night-time, or by running direct in conjunction with some form of automatic voltage regulator.

The last-mentioned was the scheme ultimately adopted, as a guarantee was received from the makers that the regulator used would give an automatic regulation within 1 per cent., with a 10 per cent. variation of the voltage on the tramway supply above and below normal, namely from 450 volts to 550 volts.

The capital cost of the various schemes was taken to be approximately as follows :—

	£
High-tension transmission with D.C. supply - -	1770
,, ,, ,, ,, A.C. supply - -	1560
Low- ,, ,, from lighting supply -	3500
,, ,, ,, ,, traction supply (with accumulators) - - - - - - - - - - -	1720
Low-tension transmission from traction supply direct with voltage regulator - - - - - -	600

The cost of the local mains network required is not included in any of the above

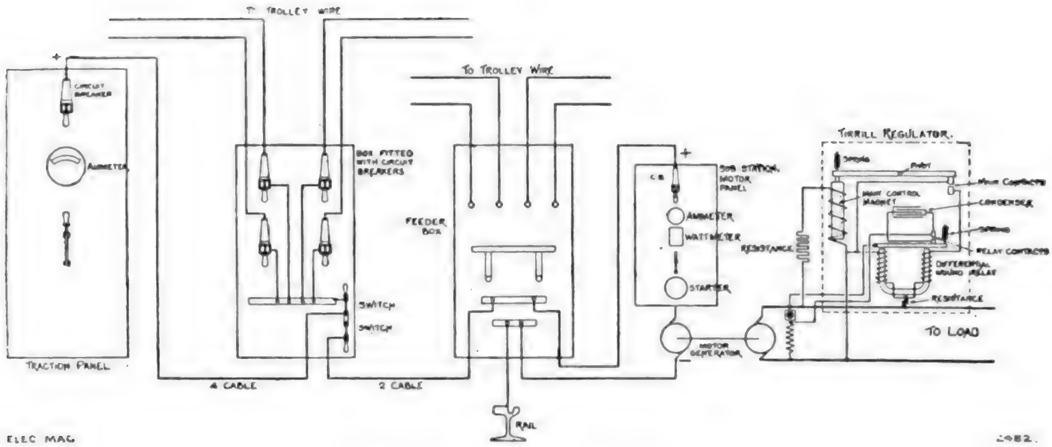


FIG. 1. DIAGRAM OF COMPLETE CONNECTIONS.

figures, as this would be practically the same in each case.

A general description of the apparatus in use is as follows:—

A ·4 feeder is taken from the panel on the traction board in the power-house (the circuit breaker controlling same being wedged up) and carried to a point on the route two miles distant, terminating in a feeder pillar containing four 200 ampere circuit-breakers and isolating feeder switches; for the remaining half-mile a ·2 cable is taken, terminating in a second feeder pillar, in which the negative connection is also made to the rails, and provision made for connecting to the trolley line in the event of a breakdown on the feeder supplying the sub-station.

From here connection is made by underground cable, both poles insulated, to the motor starting panel on the sub-station switchboard.

The sub-station is a plain brick building situated on land adjacent to the largest consumer, and contains one 75h.p. motor, direct-coupled to a 50kw. compound wound generator, space being provided for a second set if required in future.

The switchboard consists of three panels; they are:

No. 1 controls the motor and contains circuit-breaker, ammeter, single-pole switch, starting rheostat, and wattmeter; No. 2 is the generator panel mounted with ammeter, double-pole switch and fuse, automatic voltage regulator and shunt rheostat for dynamo, and also shunt rheostat for motor; No. 3 controls the outgoing feeder, and contains ammeter, double-pole switch and fuse, wattmeter, and recording voltmeter connected across the generator.

An all-night supply is not at present required, so that the sub-station is started up at 6 a.m. in the winter, and later in summer, by a man going down. His duties are to go carefully round the brushes, oiling apparatus and voltage regulator and see that all is in order for an eighteen-hour run; log the previous day's output, and take out the recording charts. The plant is shut down at 12 p.m. from the traction switchboard by opening the switch controlling the feeder supplying the sub-station. A remote control apparatus was considered for starting up from the power-house, but this would probably have led to the daily inspection being sometimes neglected, and was in consequence abandoned.

From the above it will be seen that the running labour costs are small, amounting to about 6s. per week. The current taken by the motor being a kind of steadying load on the traction generator which is run without a battery in parallel, the cost of power can be put at a very small figure, as the fuel costs at the power-house are ·20d. per unit generated. The only other costs are for oil, voltmeter records, carbon brushes and renewal contacts for the regulator, which latter amount works out to about 8s. per annum.

The Tirrill regulator, operating on direct current, requires somewhat more careful attention (as one has to deal with larger currents by working on the main shunt) than it does with alternating current, when

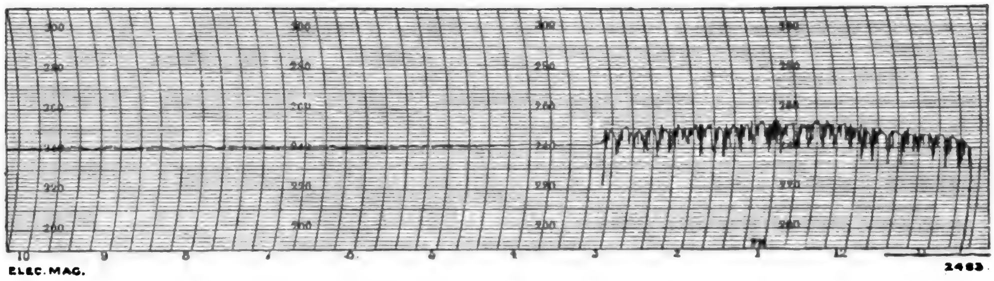


FIG. 2. RECORD OF PRESSURE WITH AND WITHOUT VOLTAGE REGULATOR.

the regulation is done on the shunt of the exciter. The operation of the regulator can be traced by reference to the diagram, Fig. 1. When starting up, the voltage of the generator is raised by the hand rheostat to about 210 volts (the supply being at 240), and the regulator is then switched in, when it immediately short-circuits all the shunt resistance that has been left in, by the spring pulling against the solenoid and closing the contacts, and the generator voltage begins to rise to the maximum of 300 volts, but on reaching the pressure for which the main control coil has been set the solenoid overcomes the spring tension and the resistance is again inserted as the contacts open and the voltage tends to fall to 210 volts. This operation is repeated at high frequency, and the resultant on the recording chart of a voltmeter with the dashpot taken off is practically a straight line, see Fig. 2, at any predetermined pressure for which the spring tension on the main coil has been set.

The only things that require attention are the contacts, and neglect of these will cause trouble; gradual burning of the silver tips must be made up for by adjustment to keep them the proper distance apart, about $\frac{1}{16}$in.; the silver must not be burned completely off, and dirt or dust must be kept off the contacts. The sparking on the relay contacts is taken up largely by condensers placed in multiple across them, but these must be assisted by cutting out with the hand rheostat as much of the shunt as possible consistent with the regulator having control of the maximum rise in voltage, for by this means the burning of the contacts will be reduced, also any chance of a flicker on the lamps with a small load on the generator.

Watch these points, and one has an ideal switchboard attendant, who, being locked up in a glass case, is not subject to the frailties of his human competitor.

The above described arrangement could, of course, be made use of to set some very nice little problems dealing with the actual division of costs as between the tramways and lighting departments, but it is obvious that if in a small town like Chesterfield, where the lighting and tramways are under one control, any interworking arrangement can reduce the capital expenditure of the combined departments and thus lessen the commitments of the Corporation as a whole, it should most certainly be considered.

The New Power Plant of the South Metropolitan Electric Light and Power Company, Ltd.

THE development of the supply system of the South Metropolitan Electric Light and Power Company, whose district includes a wide and densely populated industrial area, has been exceptionally rapid. The company was originally known as the Blackheath, Greenwich, and District Electric Light Company, which in 1900 commenced the supply of electricity in Greenwich, Blackheath, and Lee. The original area has been extended, until at the present time some 27 square miles are supplied. The extensions in 1903 included an adjoining area covered by the Lewisham and Penge Electric Lighting Orders, and in 1904 the undertaking of the Crystal Palace and District Electric Supply Company was acquired. Parliamentary powers were also granted in 1903 to the company to supply energy in bulk to tramways and adjoining electric

General View of Power Station.

supply undertakings, and in 1904 the name of the company was changed to its present more comprehensive title. The distribution is by alternating current throughout.

The following short description of the first portion of an extensive new works will be read with interest as illustrating the progress made in electrical matters in the busy East End of London, and as exhibiting the general lay-out and equipment of steam electric works according to the most modern ideas and knowledge. As previously men-

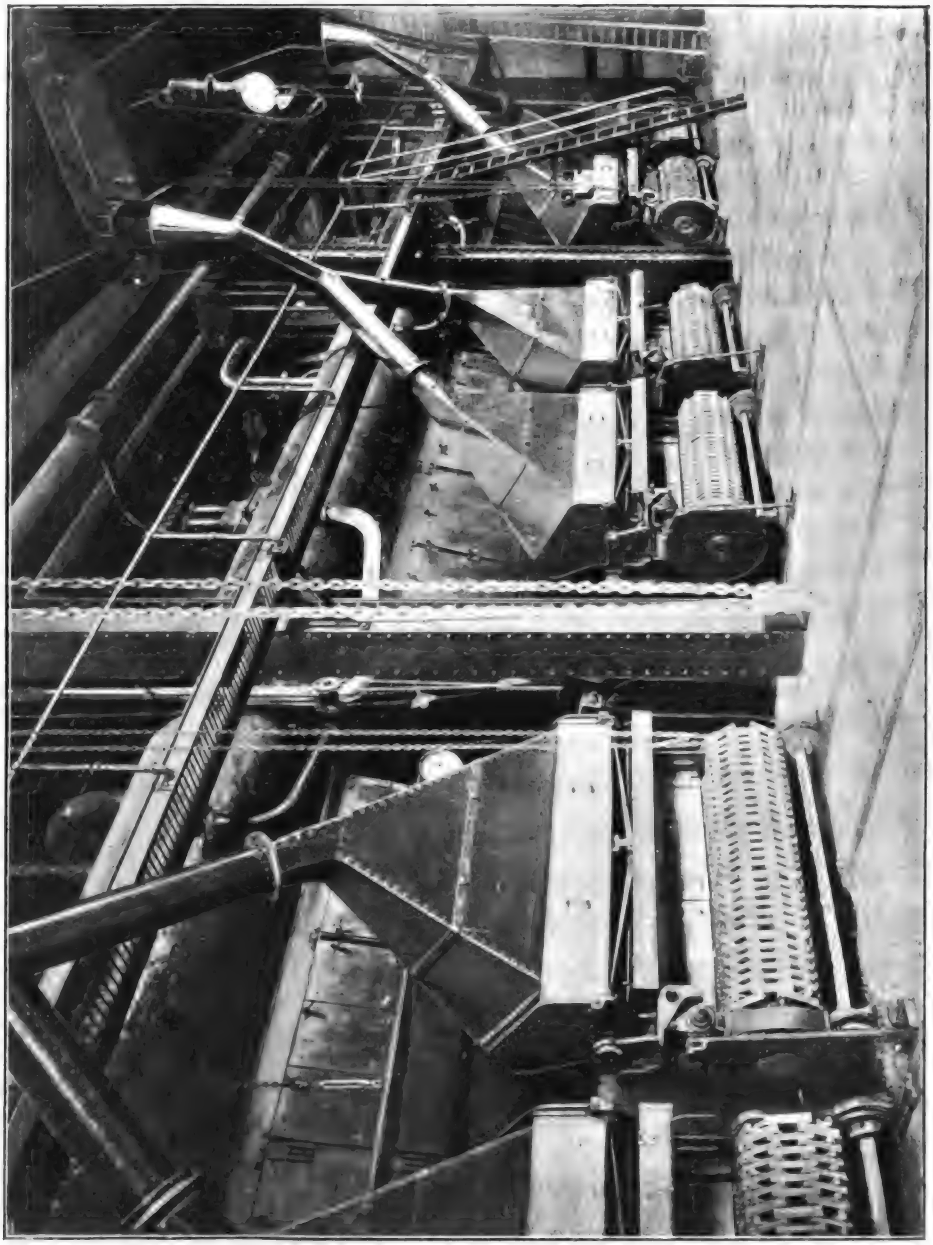
Basement of Boiler House.

tioned, this company already distributes alternating current, and its newly installed turbo-generating plant is evidence of its intention to produce and distribute electricity on the cheapest possible lines.

The new power house has been designed to admit of easy and ready extensions at low cost.

The north wing will have an ultimate capacity of 10,000kw., and the south wing of 22,000kw.

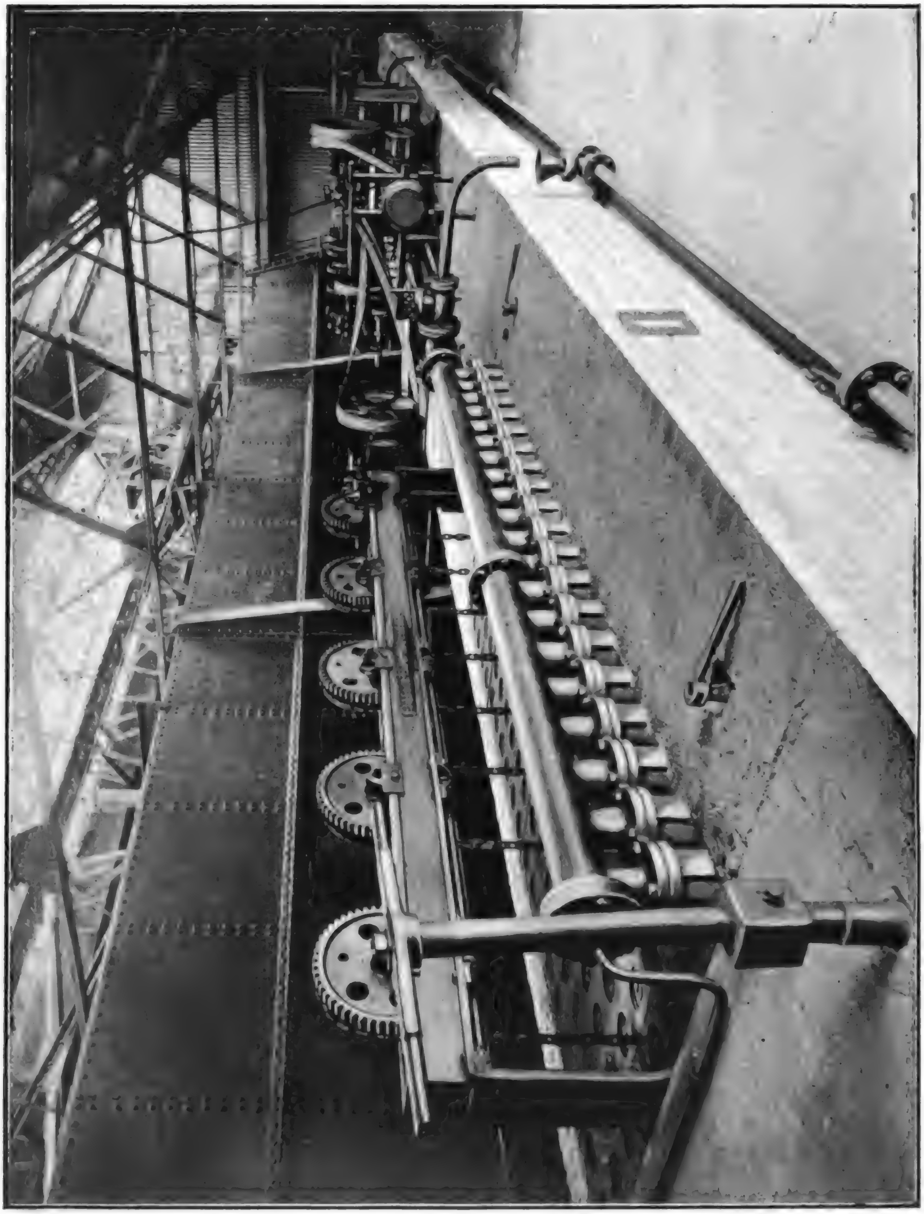
The first portion of the equipment of the former section is now complete and in steady operation. It consists of two 2500h.p. turbo-alternators, with the necessary auxiliary plant and 42in. river pipes,



Boiler Equipment. Babcock & Wilcox Water-tube Boilers, fitted with makers' Automatic Stokers, &c.

etc., which are sufficient for the whole of the north wing. The plant of the station and its proposed extensions has been designed throughout for a 25 per cent. overload (continuous working), making the total capacity 55,000h.p.

The site comprises $2\frac{1}{2}$ acres, with good river frontage and facilities for cheap coaling, and an abundant supply of water for condensing, with further facilities for coal storage on adjacent land. At present the coal is unloaded from barges alongside the quay wall, directly into bunkers, at a cost of approximately $1\frac{1}{2}$d. per ton; and when the

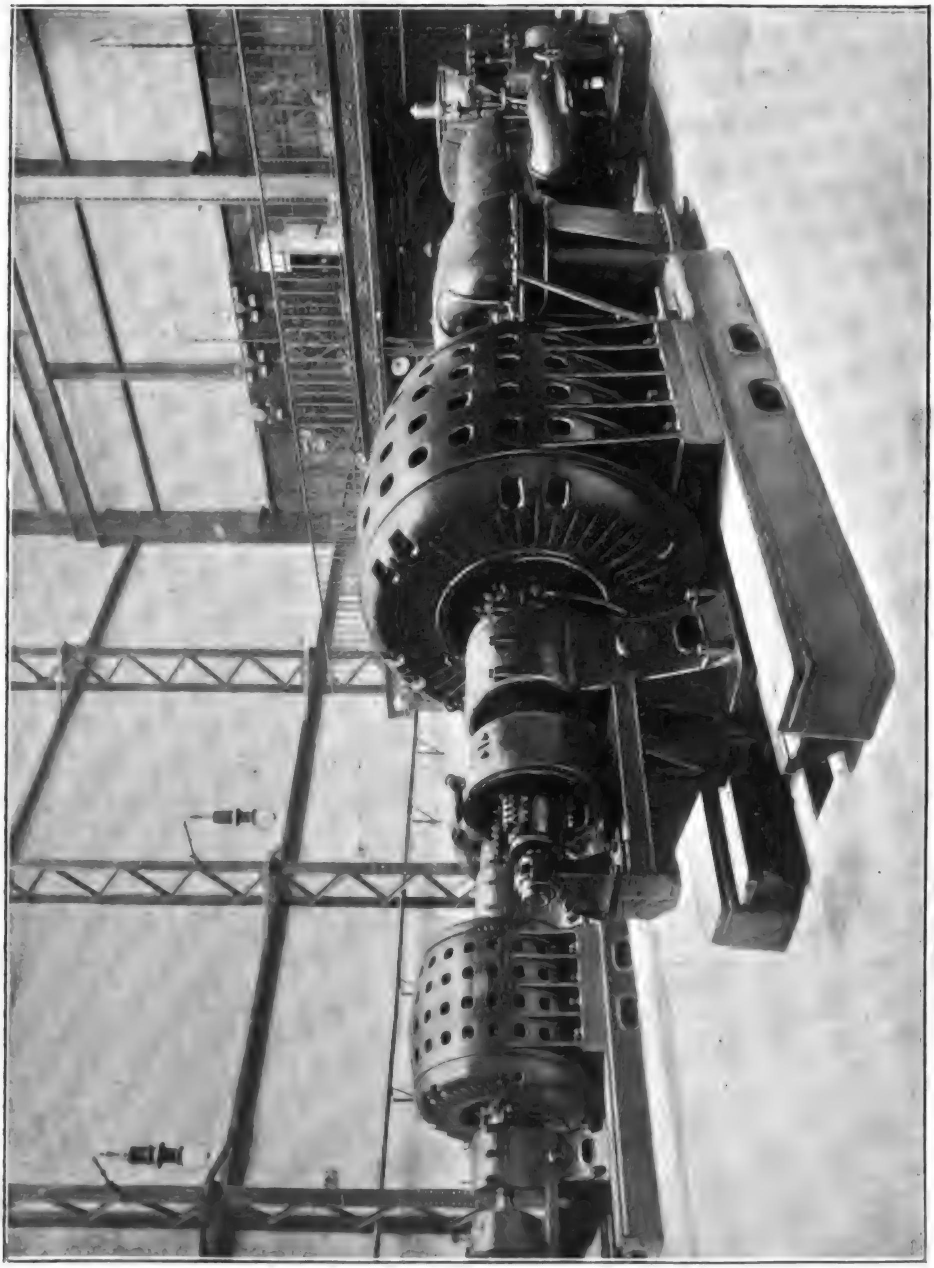


Green's Economisers. Coal Storage Bunker and Conveyor in background.

quantity of coal to be handled is greater, it is proposed to build a deep-water jetty, so that ships of 1500 to 2000 tons can be discharged, which will effect a saving in fuel of approximately 1s. per ton.

The main building is constructed of steelwork, and measures 118ft. by 116ft., and the height to the eaves is 40ft. from the floor level, the whole being erected on a concrete float, 3ft. thick, supported on piles. The chimney, built by the Alphons Custodis Company, is 86ft. in height from the ground level and 10ft. in diameter, and is carried on a separate concrete float 5ft. thick, supported on piles.

The boiler house is equipped with three



Generating Plant. Willans-Dick Kerr Turbo-Alternators.

Babcock & Wilcox water-tube marine-type boilers, each having an evaporative capacity of 20,000lb. of water per hour at 200lb. pressure, overload capacity 25,000lb. These are fitted with the makers' improved chain-grate stokers (electrically-driven), the speed of which can be varied from 6ft. to 27ft. per hour. There is a Babcock & Wilcox superheater fitted to each boiler, this being provided with a special damper gear for regulating the amount of superheat from 40deg. to 200deg. Fah. Three Green's

economisers, each of 160 tubes, also form a part of the steam plant; they are mounted above each boiler, and supplied with electrically-driven scrapers.

An electrically-driven fan, fitted between the main flue and chimney, is installed to provide induced draught, and is capable of maintaining a suction draught of 2in. (water gauge).

An overhead coal bunker of 600 tons capacity supplies the three boilers already installed and the three which will be placed opposite. The fine coal is lifted from barges by means of a crane and grab, and fed to an endless Babcock & Wilcox silent gravity bucket conveyor. The conveyor is electrically driven, and supplies the bunkers with coal at the rate of 20 tons per hour. The ashes from the furnace drop into hoppers furnished with valves, by means of which they are emptied into small wagons running along a track to the front of wharf.

Two cast-iron wells, 8ft. in diameter, are sunk on the wharf front; each contains gear for controlling the supply of condensing water from the river, the plant consisting of one Gwynne's electrically-driven centrifugal pump, capable of delivering 5000 gallons per minute, and the necessary pipes and valves. Two 42in. cast-iron pipes are laid from the wells to the bed of the river, a distance of 273ft., and at the river end of each pipe a suction box is fixed with special grating. The arrangement is such that either of these pipes can be used as suction or delivery; in other words, the flow can be reversed at will, having been specially designed to prevent accumulation of mud. As complete syphonic action is obtained, the work done by the circulating pumps is considerably reduced. From the wells to the turbine house are laid two 24in. pipes with a 15in. branch to each of the condensers.

Each turbine is equipped with a Mirrlees-Watson condenser placed immediately beneath it, having a cooling surface of 4600 square feet.

The main generating sets consist of turbines of the "Willans-Parsons" parallel-flow type, directly coupled to two 1500kva. Dick Kerr alternators, running at a speed of 1500r.p.m., having direct-coupled exciters, and generating two-phase current at 50 periods, 3000 volts. The plant is designed for continuous overload of 25 per cent., and for overloads of 50 per cent. for a period of two hours.

The steam piping is of solid drawn steel, made and erected by Babcock & Wilcox. It consists of a 10in. main, with 6in. branches from the boilers, and 8in. branches to the turbines. The water supply is obtained from an artesian well 300ft. deep and 8in. bore. A pumping plant supplies the reserve tank at the rate of 10,000 gallons per hour. A water softener of the Lassen & Hjort type, having a capacity of 2000 gallons per hour, feeds the hot-well tank with the necessary softened make-up water. There are two feed pumps of the Weir simple type, each capable of feeding 10,000 gallons per hour, drawing from the hot well and delivering through the economisers to the boilers. As water reserve supply, the Metropolitan Water Board's mains are available.

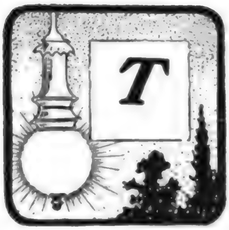
The main switchboard was supplied and erected by the British Thomson-Houston Company. It is arranged for two 1500kva. alternators, and has the high-tension apparatus and bus bars mounted in fireproof stone compartments behind the switchboard; the fronts of the switch cells are provided with iron doors. An interconnecting panel has been fixed, so that the turbine sets can be run in parallel with the reciprocating plant in the older portion of the works.

The demand for energy for power purposes in the industrial area of the district supplied has been energetically encouraged, and has in consequence grown steadily, the advantageous site on the river bank and careful engineering having resulted in cheap production, and consequently low prices can be quoted. At numerous works in the district machines of many hundreds of horse-power are driven by energy supplied by this enterprising company.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

*New Developments in Arc Lamps and High-Efficiency Electrodes.**

GEORGE M. LITTLE.



THIS paper deals with the development of the so-called magnetite electrodes and of a lamp suitable for burning them. The magnetite electrodes were so named because magnetite is usually one of the constituents of the negative or cathode, but it would be more satisfactory to call them metallic-oxide electrodes, as, in addition to the magnetite, there are always at least two other oxides present, namely, oxide of titanium and oxide of chromium.

These electrodes are made in a very different manner from the carbon electrodes. As is well known, the latter are squirted or moulded from a plastic mixture and are baked; the carbon furnishing sufficient mechanical strength and electrical conductivity. A metallic-oxide electrode cannot be made this way, for it is a familiar fact that a fine powder is a poor conductor, no matter of what it is composed, and as these electrodes are made for the most part from finely powdered oxides, it is evident that a conducting binder or a conducting case would have to be used. In practice, the mixture of oxides is tamped into a thin iron tube and the end sealed in an arc.

The oxides have distinct and separate reasons for their presence. The titanium oxide has the property of rendering the arc luminous; and it may be here noted that the metallic-oxide arc is a flame arc, the light not coming from a crater as with carbons. The oxide of iron gives conductivity to the fused mixture when cold, the other oxides being conductors only when hot. The oxide of chromium prevents a too-rapid consumption, so that by its use an electrode may be given a very long life.

The positive, or anode, used with these metallic-oxide negatives is generally a metal and is consumed much more slowly than the negative. This is contrary to what would be expected, judging by the action of carbon electrodes.

There are a number of advantages possessed by the metallic arc over the carbon arc.

A metallic arc lamp operating on a 4amp. current with approximately 65 to 70 volts at the arc will give a light equal or superior to that of a 6.6amp., 75-volt, direct-current, enclosed-carbon arc lamp.

* Abstract of paper read before the National Electric Light Association, Washington, D.C., June 5, 1907.

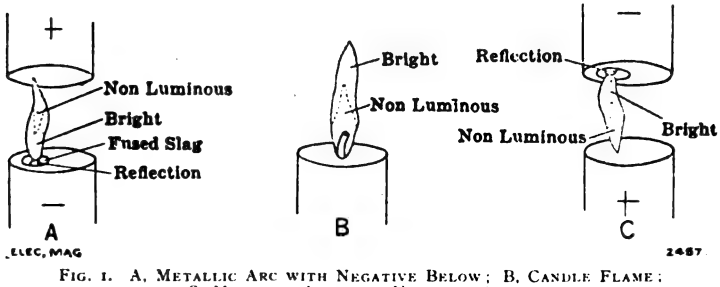


FIG. 1. A, METALLIC ARC WITH NEGATIVE BELOW; B, CANDLE FLAME; C, METALLIC ARC WITH NEGATIVE ABOVE.

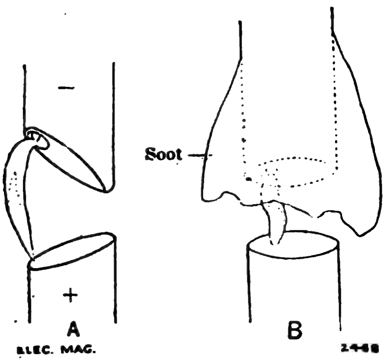


FIG. 2.

In the enclosed-carbon arc practically all the light comes from the crater on the flat under-surface of the upper electrode, most of it being thrown down and not serving to illuminate the street between lamps. The light from the carbon arc itself is weak and of a blue colour. This is very pronounced at times, especially if the flat under-surface of the upper electrode is somewhat inclined, thus hiding the crater. In the case of the metallic-oxide electrodes, the arc is itself the source of light, practically none coming from the crater, except by reflection. The metallic arc is much like a candle flame, having its luminous and non-luminous zones. The light is brightest near that end of the arc which is next to the negative electrode, and comes from a hollow, cone-shaped mantle of volatilised oxide of titanium rendered incandescent by the heat of the arc, just as in the candle flame the light comes from a hollow cone-shaped mantle of carbon particles made white hot by the heat of the flame.

The voltage required to maintain a metallic arc is less than that of an enclosed-carbon arc. It is a well-known fact that an enclosed-carbon lamp will not burn properly with the arc voltage down to 65, while a metallic arc will burn well at less than 55 volts.

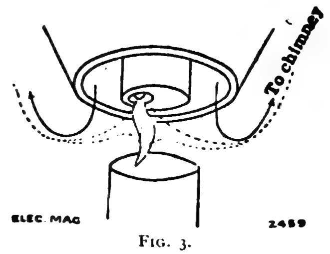


FIG. 3.

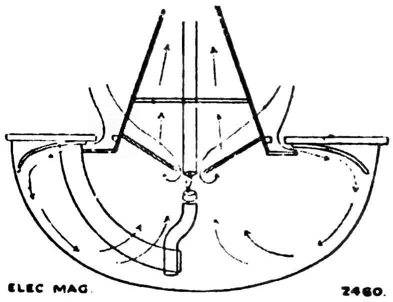


FIG. 4.

Metallic arcs are adjusted to burn at from 65 volts to 75 volts in different cases, while the carbon arcs are all set at 80. This is a very evident advantage in favour of the metallic arc, as more lamps may be put on a circuit without raising the voltage on the line.

The life of carbon electrodes, as a rule, is not over 150 hours, while the metallic-oxide electrodes can go considerably longer.

The uniform white colour of the metallic arc is in marked contrast to the changeable blue and white of the enclosed-carbon arc.

As the metallic-oxide electrodes are not burned "enclosed," there is no inner globe required on the lamp.

While it looked easy to secure all of these advantages, many difficulties appeared, but they have now practically all been overcome. In the first experiments the electrodes were placed with the positive above and the negative below, but troubles presented themselves :—

The bright portion of the arc was near the

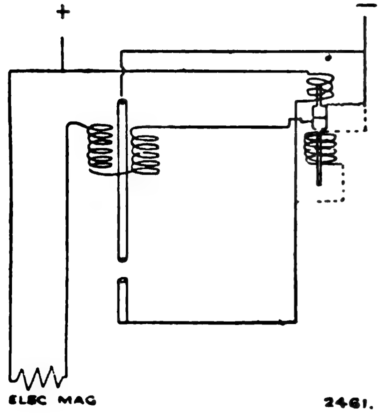


FIG. 5. DIAGRAM OF LAMP CONNECTIONS.

surface of the lower electrode, which cast a large shadow;

The light reflected from the brilliant surface of the fused slag of the lower electrode being thrown upward could only be partly saved by using a reflector.

The negative, lower electrode being more rapidly consumed necessitated an underfeed mechanism.

Only a short negative could be used and the hours of burning were thus limited.

A particularly undesirable feature was the gathering of a large amount of reddish soot that would collect in spongy masses around the electrodes, obscuring the light. This had to be removed by some mechanical means, such as scraping or shaking it off, and some receptacle other than the glass globe had to be provided to catch it.

The metallic electrode burned to a blunt taper point, the arc being unsteady, and tending to travel up the side of the electrode.

It was thus seen to be very desirable to burn the electrodes with the negative above. Attempts to do this showed that there were many obstacles to be overcome. In the first place the upper electrode would waste on one side and the arc, travelling upwards, become unsteady (Fig. 2, A). In the second place the volatilized oxides condensed on the sides of the electrodes and obscured the light (Fig. 2, B).

The first attempt to overcome these troubles was the introduction of a rotating draught of air round the arc. This held the arc central, stopped the uneven burning, and steadied the light, but did not take care of the fumes. Attempts to blow the fumes away sideways gave only partial success. Finally a current of air directed around the arc gave excellent results. The electrode burned square, and the fumes being exhausted no soot was deposited, but passed away out of the lamp chimney (Fig. 3).

When burning metallic-oxide electrodes with the oxide stick below, a copper anode gave fair results. On reversing the position of the electrodes it was found possible to improve on the action of the pure copper anode. If the arc plays for a time on pure copper it will oxidise the surface. This oxide will fuse to a slag which is an insulator when cold, so that on restarting the lamp it is necessary to strike the electrodes together hard enough to break through the slag. To strike such a hard blow is undesirable, as it is liable to spatter the fused slag out on to the glass globe. A remedy for this consisted in using an anode of metals or alloys, whose oxides, when fused together, would make a slag that is a good conductor when cold. The steadiness of the light largely depends upon the composition of the slag, its uniformity and temperature. The anode surface is at all times covered with this slag, which slowly dissolves the metal and is itself slowly volatilized. If the arc plays on bare metal it consumes it rapidly, and it was found desirable to secure this slag cover from being knocked off. This was accomplished by providing a rough surface for it to cling to, and by running the entire anode tip very hot.

A characteristic property of the metallic arc has been a very noticeable dying-down or dimming of the light, which would occur at irregular intervals, especially after the electrodes had burned for twenty hours or more. These dim spells would last from a few seconds to two or three minutes, when their normal brilliancy would return. This is explained as follows: In the metallic arc the brilliancy is largely due to the presence of volatilized oxide of titanium, and anything that interferes with the uniform evolution of vapours of titanium will cause the light to dim—for example, the presence of a high percentage of highly fusible oxide of chromium. This oxide of chromium is volatilized at a slower rate than the oxides of titanium and iron, and after the electrode has been burning some twenty hours the slag on the cathode has become rich in oxide of chromium, which forms a film on the surface of the pool of oxides. When the film is not present there is a plentiful evolution of oxides of iron and titanium, and there is a bright arc. The oxide of chromium can be seen to gather on and finally to cover entirely the surface of the pool. This stops the evaporation of titanium and iron, and the light burns to a bluish colour and dies down until the chromium film is burned away again. This trouble was met by modifying the mixture in such a way that the oxide of chromium could not separate from the oxides of iron and titanium, thus doing away with the film on the surface and entirely doing away with the dim spells.

In carbon lamps there was very little done to keep the impurities volatilised from the carbons from depositing on the globe. This trouble had to be met by the carbon manufacturers, who were prodded up to produce

carbons containing less than 0.2 per cent. of impurities, but this means was not to be considered in the case of the metallic-arc lamp. The metallic-arc electrodes, being chiefly composed of oxides of iron, titanium and chromium, do not burn away to an invisible gas as does a carbon stick, but are volatilised bodily, and the vapours instantly condense, on leaving the arc, to a fluffy reddish soot that settles on everything it touches, so that a chimney is a very necessary feature in the lamp. This soot, if it comes in contact with the reflector or globe, will smudge them badly in ten minutes. As was noted before, a current of air flowing down around the electrode served admirably to keep it clean, so it was applied to the reflector and globe with gratifying results. A thin layer of air is introduced at the top of the reflector and forms a shield through which the soot-laden air cannot penetrate; the reflector and globe keep clean for a long time (Fig. 4).

As the air currents play such an important part in this lamp, it became necessary to do a large amount of experimental work on the design of an air intake and of a chimney top. The chimney could not be made long enough to cause a very powerful draught, so the wind was very apt to blow down it; but by persistent effort the openings have been so designed that the wind may blow from any direction, the only effect being to increase the natural draught in the lamp. Incidentally, the increasing of this draught actually centres the arc, and holds it remarkably quiet.

It was found advisable to run the lamp at 4amp. and 65 to 68 volts at the arc with a cut-out set at 85 volts. This low cut-out was made possible by the inverted position of the electrodes and by the peculiar arrangement of the air draught, which prevented any tendency of the arc to flame or to run up the side of the electrode. Without these features a cut-out of 100 to 110 volts would be necessary. As the power factor at which the lamps operate depends largely on the amount of variation of voltage in the arc, this 85-volt cut-out is seen to be very desirable. In actual service the lamps, including a mercury arc rectifier, run very well at from 65 to 70 per cent. power-factor.

A Colour Meter.

An instrument devised to enable definite figures to be assigned to the colours of objects has been designed by F. E. Ives, and is described in the *Journal of the Franklin Institute* for July. It consists in comparing the colour of the object under test with a colour band, which is formed by mixing in the required proportions the three primary colours—red, green, and blue—obtained by means of a defraction grating. The instrument is a portable telescope with an objective lens which forms an image of the object to be tested within the telescope, the light for this purpose being admitted through a narrow slit. At the same end of the instrument are three other slits properly spaced so that each of them, by falling upon the grating, will give rise to a ray of light of a definite colour, which will be seen through the eyepiece of the instrument. By means of slides and adjusting screws, the width of each of these slits may be varied at will, thus varying the intensity of the corresponding ray of coloured light. This portion of the instrument is separated from that through which the light directed from the object being examined is admitted. Within the instrument the defraction grating is arranged so that the direct ray from the object passes above it, while the other three beams fall upon the grating and are there defracted, producing the three primary colours as mentioned. When in use the instrument is directed at the object to be examined, and a pure white screen is held in front of the three colour slits. By this means pure white rays are admitted through the three slits. The width of these slits is then varied, thus admitting more or less red, green, or blue light, as may be necessary, until the colour of the band thus formed is judged to be equal to and the same as that of the object under test. By scales on the adjustment screws the position of each of the colour-slit slides is read off, and these give on an arbitrary scale the value of the colour. Knowing these figures, this colour can be reproduced exactly at any time, and definite colours may thus be selected, although samples for comparison may not be at hand.

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Submarine Telegraphy.

"REALISTIC history is a practical and interesting weapon of instruction. It commits points to memory so well." In such words did Mr. Charles Bright, F.R.S.E., introduce the second portion of a highly interesting lecture delivered at the Royal Institution in April last. The May number of the ELECTRICAL MAGAZINE contained a review of the first portion of the lecture—that which dealt with the principles of submarine telegraphy, the manufacture and manipulation of cables and apparatus. The author's historical treatment of the subject has perforce had to be held over until now. Mr. Bright starts his history from the first attempt made to commercialise the submarine telegraph.

Unquestionably, the *bric-à-brac* shopkeepers, Jacob and John Watkins Brett, were the first to deal with submarine telegraphy from a public and commercial standpoint. On 16th June, 1845, they registered a company for the purpose of telegraphic communication between this country and France; and a little later they addressed themselves to the Prime Minister, Sir Robert Peel, who did not, unfortunately, share their confidence.

This move, indeed, only involved the Bretts in a departmental correspondence—more academic than useful—in which they were diplomatically passed backwards and forwards from one Government office to another.

By 1849, however, the Bretts had obtained consent from the authorities of both countries to lay a cable across the Straits of Dover.

The first submarine cable was indeed the essence of simplicity: it consisted merely of a single wire covered with gutta percha. The telegraph instrument was set up in a bathing machine. And this was less than sixty years ago! Amateurish as this early effort may appear in view of the present huge development, even at that time the venture was only generally noticed with ridicule.

It was, indeed, looked upon as a mad freak—and even as a gigantic swindle—indulged in only by wild minds. When accomplished, the *Times* remarked, in the words of Shakespeare:—"The jest of yesterday has become the fact of to-day." But a few hours afterwards it might with equal truth have been said:—"The fact of yesterday has become the jest of to-day!" Messages were, however, certainly sent through this insulated wire.

Brett had a document, signed by twenty Frenchmen, dated 6th September, 1850, who declared that they had seen the electric telegraph working between France and England. The signals, it must be confessed, were rather incoherent; the operators at each end blamed those at the other, and tauntingly suggested that the excitement, or something else, must have gone to their heads. In any case, the glory of this telegraph was, unfortunately, short-lived, for after the first evening it maintained an obstinate reserve, and never spoke again. An attempt was then made to raise the wire; but as a leaden weight had been attached at every hundred yards, in order that it might be successfully sunk, all efforts were in vain. However, a considerable length was brought up by a fisherman in his trawl, who carried it off to Boulogne in triumph, as a piece of rare seaweed with a pith of gold!

This unfortunate beginning had the not uncommon effect of spurring on the promoters to further plucky efforts, their perseverance being more than ever tested by the public disbelief created by signal failure. In 1850 the French Government granted a concession to Jacob Brett, and the Submarine Telegraph Company was formed.

But £300 was all that the public would subscribe, because it had been *proved* that submarine telegraphy was an impossibility! Yet these early pioneers, with that peculiar obstinacy that characterises inventors, actually went on believing in their own ideas.

Mr. Crampton, the well-known railway engineer, came to the rescue with £7500 of his own and a similar amount from his friends. Then Mr. Küper, a colliery engineer, came along and said: "Why not protect your gutta percha covering by an iron sheathing?" Well, the cable with its sheathing was made, and on 25th September, 1851, a procession, with a man-of-war to lead the way, started from the South Foreland to the shores of France. All went well until they were in sight of the opposite coast, when the cable gave out. Another mile was ordered, manufactured, and laid; and on 13th November, 1851, the public sent a message through a submarine cable for the first time in the history of the world. There were four insulated conductors covered with hemp and iron wires. The cable had a very good life, and this class of armour has been adhered to ever since.

The next phase was further and greater difficulty in overcoming official prejudice and red-tape. In this respect matters were then as now. The author is quite amusing in following the tussle that ensued between the obstinate pioneers and the cautious, slow-moving Government.

The Bretts applied to the Government for a monopoly to electrically connect England and Ireland. This time they were not so fortunate; for on the 10th of September the Admiralty wrote that "they had watched with interest the progress of the experiments, but had no power to grant a right." On the 18th the "Foreign Office is directed by Viscount Palmerston to congratulate you upon the success of your experiment, and to state that the matter does not relate to the business of his lordship's department." On the same day the Admiralty again wrote "that whatever privileges can be granted, can proceed only from the Treasury."

The next day the Treasury "acquaint you that it is not in the power of the Lords Commissioners of Her Majesty's Treasury." They got the same answer on 28th September. On 18th October, 1850, they received the following letter from the Treasury:—"Although sensible of your perseverance in bringing the submarine telegraph about, and in view of the great public benefit likely to arise in connection . . . but it is not in their lordships' power," &c.

Mr. Bright proceeded to tell how eventually a cable was laid between England and Ireland. Even in this case three attempts were necessary; the narrator having the happy experience of relating that this successful work was carried through by his father, Mr., afterwards Sir Charles Bright, whilst on his honeymoon and at the age of twenty-one.

After this there followed a good deal of Channel and Mediterranean work, with varying degrees of success.

We now come to the period when a much more difficult problem was dealt with—spanning the Atlantic Ocean by laying and speaking through a cable 2000 miles in length, the depth being upwards of three miles. Many eminent scientists had said it would be impossible to deposit the line at all at so great a depth; and that even if laid it would be a mathematical impossibility to transmit electrical signals through such a length. The Atlantic cable was, indeed, considered at this time (1857) a wild freak of people that were to be pitied.

Portraits of the three leaders in this venture were shown. Mr. Brett had, as mentioned, already been associated with other pioneer cables; Mr. Cyril Field was a wealthy American business man of far-seeing and enormously active character; and the author's father had already attracted considerable attention as an engineer.

There were evidently some spirits who believed in the enterprise—or in those at the back of it—for the Atlantic Telegraph Company was formed within a few days, the capital being raised almost entirely in England by the public issue of 350 shares of £1000 each.

The proposed route was surveyed in what we should nowadays consider a somewhat "sketchy" fashion.

The manufacture of the cable was duly proceeded with—partly at Greenwich and partly at Birkenhead, near Liverpool. The outer wires were composed of several strands of fine wire. This stranded sheathing had certain mechanical advantages at the outset, but has since been found by experience not to be a durable type of armour.

The Governments of the countries concerned encouraged the scheme to the extent of lending certain vessels for laying the cable, as they had done previously for the survey.

The main contribution from the United States was the *Niagara*, a splendid example of the frigates of that time. A smaller vessel was also provided by each Government to land the ends, pilot the way, and act as consorts generally.

Mishaps soon occurred; for it was only four miles that had been paid out when the cable broke. Another start was made, but after 226 miles had been laid it again broke—this time, however, at a depth of two miles. So ended the first attempt to electrically connect America with Europe. Morse, who was on board in an honorary capacity, recorded the circumstances as follows:—"The cable parted just before daybreak. The machinery having stopped, all hands rushed on deck and gathered

in mournful groups; their tones were sad, their voices low, as if a death had occurred on board."

The next year (1858) more cable was made, and a second expedition started with 3000 miles. The two vessels were this time to meet in mid-ocean and make a joint, and then sail in opposite directions, laying the cable towards their respective shores. This they did, but the joint broke. They made a second, and again it broke. They made a third, and then one ship sailed towards Ireland and the other towards America.

On her way the *Agamemnon* encountered a whale, and though the monster got temporarily mixed up with the cable, this was attended with no evil results. The *Niagara*, however, had not gone far before another break occurred, which ended in the loss of 500 miles of cable. Sufficient yet remained on board for a third trial.

Meanwhile, however, both ships had run out of stores, and it was therefore necessary to put into Queenstown. On the way a terrific storm was encountered, and the *Agamemnon* nearly "turned turtle."

The boots, food, and crockery—not to mention the coals—got, of course, terribly mixed up—but so did the cable in the tanks; and this was a much more serious affair.

Matters were, however, righted, and after stores had been procured the telegraph fleet again met in mid-ocean to make the splice, and again set forth on their respective work. The first expedition created considerable excitement, but when it came to the second and third, everyone—except the shareholders—merely pitied those that were continuing such a futile errand. However, the pity was now beginning to be misplaced, for this time the entire line was laid successfully.

Though having little to do with the actual work, our American cousins were, as might be expected, more demonstrative on the subject.

But even the *Times* remarked: "Since the discovery of Columbus nothing has been done in any degree comparable to the vast enlargement which has thus been given to the sphere of human activity."

It was on August 5th, 1858, that England spoke for the first time electrically with America. Formal and reverential were the first words of greeting between Her Majesty Queen Victoria and the President of the United States.

It must be admitted that the cable never worked very satisfactorily from the outset, for the message from the United States President to our Queen occupied over thirty hours in transmission, though only containing 150 words! Moreover, the utmost speed achieved was some six words a minute, whereas a modern Atlantic cable with modern implements can be worked up to 100 words per minute.

But though the line did useful work for some two months, it was gasping under its efforts throughout, and gradually reached the sinking stage.

The line was suffering—and ultimately succumbed—from the effects of mistaken electrical views, in which even the great Faraday shared. The line was, indeed, an electrical failure, though a complete engineering success. It had been proved that such a length of cable could be laid in really deep water; and though various mishaps had occurred before final engineering success was achieved, these were only due to unavoidable accident on the one hand, and lack of perfection in manufacture on the other, such as could be improved on by the experience gained. My father, the engineer-in-chief, was knighted at the age of twenty-six in connection with this pioneer work.

From the next cable, however—that laid by the Government in the Red Sea in 1859—nothing useful was learned. The sections failed one after the other, and it is doubtful whether a message was ever sent through the whole of the cable; but it is certain that the British public have paid, are paying, and will continue to pay till 1908 £36,000 a year for the privilege of having put some copper wire, gutta-percha, and iron sheathing at the bottom of the Red Sea.

There were several other cables laid soon after—from Malta to Alexandria, to India, and elsewhere, and these proved a complete success. A little later a project was mooted for an extreme North Atlantic cable, with stepping-stones at Iceland and Greenland; but possibly the temperature there was not sufficiently inviting, for certainly the scheme came to nothing.

It was not until 1865 that the question of re-spanning the Atlantic took active shape. My father had, in the interval, persuaded the powers that be that a larger and more costly insulated conductor was essential. Moreover, the electricians were also better advised in regard to the generating power and apparatus for signalling purposes; indeed, Professor William Thomson (now Lord Kelvin) had not only introduced his mirror speaking instrument, but was taking a more active part in the electrical arrangements generally.

Despite repeated failures, or perhaps at this stage they might be termed accidents or mishaps, there was apparently a rapidly-increasing circle of influential people who had unbounded belief in the ultimate success and practicability of the long-distance submarine telegraph.

In the 1865 cable several faults occurred; and it was feared they were produced intentionally by people on board sticking pins or iron wire through the gutta-percha. They watched the tanks, but still the faults occurred, and while attempting to haul the cable back to

repair a fault the cable snapped, after 1186 miles had been laid.

For nine days they made strenuous efforts to pick up the cable; but though they grappled it many times, the rope broke, and thus the 1865 cable had to be abandoned. A new cable like that of 1865 was then made by the Telegraph Construction and Maintenance Company. This company contributed £100,000, and undertook to make and lay the cable for half a million of money, whether it was successful or not, this sum to be increased to £600,000 if it were successful, and to £737,000 if they could also pick up and complete the 1865 cable. So three-quarters of a million of money was the prize; and it was won. Nowadays the prize would be only half a million for a cable giving, of course, far better results.

This new cable, after a few further misfortunes, was eventually laid.

From an engineering standpoint, however, this was really work that had already been effected eight years previously with about the same number of misfortunes, though with no applicable experience to go upon.

The work to come—that of recovering the 1865 cable—was, indeed, the matter of the moment.

For thirteen days they alternately hooked and lost the cable. Once they brought it to the surface; but it slipped away from them like a great eel. On lowering the grapnel, however, for the thirtieth time they succeeded, thanks to Sir Samuel Canning, the engineer to the contractors, and thus two good cables were laid between England and America.

Other cables to the East and Far East followed in more or less rapid succession; and these, thanks to the commercial foresight and enterprise of men like the late Sir John Pender, have all proved a lasting success.

There are now as many as fifteen cables across the Atlantic and several different routes to various Eastern points. Further, there are the much-discussed All-British Pacific cable to Australasia, and also the more recent American Pacific cable to Japan. Both these run over depths of *four miles;* and just as the first Atlantic cable was considered at the time a wild freak of people that were to be pitied, so also the first Pacific cable was similarly spoken of by some, mainly on account of the great length—materially over 3000 miles—of one of the sections. It was, however, laid almost without a hitch, and will no doubt serve an increasingly useful purpose.

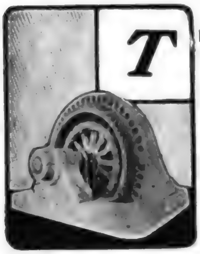
In conclusion the author laid stress upon the fact that in the making of submarine cables this country practically retains the monopoly to this day. Referring to the development of wireless telegraphy, Mr. Bright is not one of those who believe in the early consignment of cables to the region of antiquarian museums, though he has great faith in the utility of wireless telegraphy for all maritime purposes and as a helpmate to cable systems.

Certainly, so far, there are no signs of cables being replaced by wireless telegraphy when further means of communication are required. Only a few weeks ago, whilst reading in Egypt the record of a meeting in which the chairman of a well-known cable-making company was reported as stating that "Marconi had done away with the manufacture of telegraph cables," I also, by the same mail, received news that the three large cable works were particularly busy with submarine cable orders just received for various parts of the world; and perhaps it should be added that on inquiry I was informed on good authority that the chairman in question never expressed what he was reported to have said.

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

The Selection of Machine Insulation Material.

WILLIAM S. CONANT.



THE practical electrical shop worker may ignore all discussion of the insulating value of air or of oils and gums in their fluid state. These considerations belong more properly to line construction problems or the design of apparatus for high-tension transmission.

Materials intended for the insulation of electric machinery should pass three classes of requirements, involving tests to withstand (1) current leakage, (2) lightning discharge, and (3) heat. These classifications may be made to include as kindred under (1) not only the actual insulation resistance tests, under any set of conditions, measured in megohms, but hydroscopic or moisture-resisting tests which affect the insulation resistance of many porous materials; under (2) determination of resistance to disruptive discharge from any cause, whether accidental metallic contact with a high-tension transmission line wire, proximity to high-frequency wireless station apparatus, or static discharge during a thunderstorm ; under (3) tests covering the effects due to the presence or absence of heat, such as the mechanical failure of materials with the extremes of temperature and with the rapid alternation of heat and cold.

No station leads from an overhead line can be absolutely protected from lightning discharge, and too frequently the high-potential strain from this cause reaches the insulation of electrical machinery. Disruptive discharge, whether from lightning or other source, acts like a fluid in motion, with erratic splashings which have been called side flashes. These uncontrolled discharges have been found to strain and break down the insulation at any point, but are most liable to follow surface leakage, as in taped windings or over a moisture-soaked varnish. Discharges will leap over such surfaces and cause short circuits and earths by the secondary effect of the following dynamo current burning out the machine insulation. Designers therefore, as far as possible, avoid the materials which promote these risks, and allow large margins of safety in the actual disruptive strength of the insulating layers.

The mechanical design of a machine may allow in many places the use of a thick layer of insulation, and thus a greater selection of materials is available. Often, however, the insulation layer must be extremely thin, and great care is required in its preparation. In either case tests to determine the disruptive strength of a material should be made on such thicknesses as are designed for practical use. For instance, mica, which in its natural state is in a class by itself, will withstand approximately ten times the e.m.f. applicable to other sheet insulations, and various samples of mica should be compared in thicknesses measuring either .1mm. or about 5 mils (.005in.). A suitable thickness for test samples of most other materials is 1mm. or .04in. This comparison of equal thicknesses of different materials is important, as it has been found by trial that the disruptive strength does not increase directly with the thickness of the dielectric. Mica and

paraffin seem to be about the only insulating substances of which this is practically true.

The following particulars of methods of testing the properties of the more commonly used forms of insulating materials appeared in a recent number of the *Electrical World*, forming part of a very complete article on this important subject:

At first thought it might seem to be an easy matter to select all the obviously best insulating materials, solid and semi-fluid, to combine them in various proportions, and to submit them severally to a series of tests to determine definitely their relative values as insulators. Unfortunately, the specific resistance of insulating materials varies widely under changes of external conditions, and does not follow the results of similar tests upon electric conductors. A change in the condition of heat or of moisture will often effect a decided change in the relative value of a simple or compound dielectric. It is necessary, therefore, to experiment with the treatment of varying the thicknesses of insulating materials, and to select those which do not break down under high-tension tests. Then we must again apply to the materials passing these requirements working conditions of heat and moisture.

The charring temperatures for the following materials were obtained by immersing samples in a bath of lead, tin, and antimony, having a melting temperature of 230deg. F.: Shellacked cambric, 320deg.; oiled duck, 8oz., 338deg.; oiled duck, 10 oz., 347deg.; drilling, untreated, 347deg.; cambric, untreated, 355deg.; leatheroid, 360deg.; thin silk, oiled, 392deg.; thin silk, untreated, 428deg.; surgical brand cotton, 447deg.; glazed pressboard, thin, 465deg.; glazed pressboard, thick (.03in.), 483deg.; fine linen, 483deg. The oiling was in each case with linseed, and its result was to lower the carbonization point.

It may not be out of place to refer to some of the causes for the apparent discrepancy of test figures coming from different sources. If the disruptive strength of a material per thousandth of an inch is to be found, it is obviously important to use consistently either direct or alternating current. For convenience in obtaining high pressures alternating current is preferable. Uniformity of results is also only obtainable by using rounded discs for terminals. The proper size for these discs is a matter of dispute, but a fair average might be formed in the size of a shilling. Again, it is absolutely necessary, in order to obtain consistent results, to compare approximately equal thicknesses of material tested. Lastly, the time conditions must be equalized for each sample—by which is meant that the causes which affect the insulation strength of a material (whether electrical or mechanical pressure, heat, or moisture) should be applied under equal conditions for the same length of time to each sample. Fifteen seconds is a suitable period for the application of electric strain. A longer period may heat, and consequently weaken, a sample unduly. Newly-made samples should not be compared with those which have stood for some time. The "green" sample may not have reached its natural strength, while aged samples have had opportunity to develop intrinsic weaknesses due to internal chemical decomposition.

Some test figures might be added illustrating the points emphasized. Also perhaps some notes upon the characteristics of certain mixtures and the effects of certain ingredients.

Mica.

It can be safely said that no satisfactory substitute has been found for mica in commutator construction. The commutator is the hottest part of a machine, and mica will not carbonize. Between segments nothing but amber mica should be used, as it can be turned in a lathe without chipping as deeply as other varieties, and thus the risk of pitting and subsequent flashing under the brushes is lessened. White mica is harder than amber, but much more flexible. A good quality of white mica splits into larger sheets, and its flexibility makes it most applicable to repair work, particularly on old surface-wound machines. All variations from white, noticeably greenish or bluish tinge, are harder and more brittle. Metallic veins and chemical impurities are the bane of the mica dealer.

The ultimate disruptive strength of a selected quality of amber mica taken from a number of samples of thickness up to 5 mils varied from 1980 volts per mil to 4300 volts, the average failing at about 2500 volts. The averages of two assortments of poorer-grade mottled samples from different localities were 2200 volts and 2400 volts per mil respectively. White mica in both large

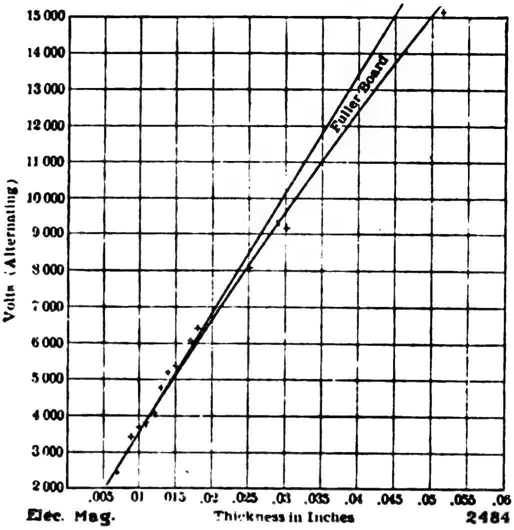


FIG. 1. TESTS OF FULLER BOARD.

and small sheets averaged 3100 volts per mil. Similar qualities of mica show little difference in strength, whether mined in the United States, Canada, or India.

Mica Compounds.

The successful building up of thin overlapping sheets and the moulding of finely divided mica into plastic forms have simplified the insulation of many machine parts. The use of hydraulic presses produces a uniform product. These insulations, known under several trade names, share to some extent the insulating value of mica. Built-up mica, if cemented with a non-hydroscopic varnish, possesses a disruptive strength practically proportional to the thickness. Backed with tough paper or cloth for mechanical strength, it has advantages over pressboard or other fibrous insulators for core, slot, or coil work. Micanite can be

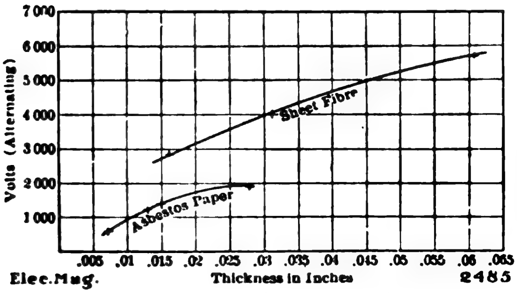


FIG. 2. TESTS OF SHEET FIBRE AND ASBESTOS PAPER.

made to within .01in. of desired thickness, and can be milled even closer.

Sheet Insulation.

One of the most widely useful insulations is flexible glazed pressboard. Thicknesses over .03in. should be avoided. If space must be filled, it is better to use two thinner sheets. The best quality is made of leather findings and comes in yellow and red. Spruce or other wood fibre is unsatisfactory mechanically unless a sulphide process is used, when, on the other hand, its insulating quality is reduced. The unexpected presence of pin-holes or non-insulating particles too small for detection by the eye is the chief fault of this material.

In Fig. 1 is plotted a series of readings, each point representing the average of eight breaking voltages on a given thickness of fuller board. The thicknesses tested were from 7 mils to 51 mils, and show a uniform increase in disruptive strength rare in sheet insulation. Even on the thickest sample tested the strength was only 14 per cent. below the theoretical straight line of strength proportional to thickness, while for a thickness of .025in. it was but 8 per cent. below.

For thicker insulating sheets the whole family of vulcanized or hard fibre preparations is available, including such kindred materials as bone fibre, kartavert, amyloiden, leatheroid, &c. Where flexibility is required the temptation to the maker to use glycerine is often fatal to the electrical properties demanded. Baleen or whale oil is less harmful for this purpose. This is the class of materials, too, where moisture plays havoc, and where, after thorough drying out, the insulation resistance may usefully be measured. Pressboard and vulcanized fibre shrink when hot and swell when damp. Drying out adds about 20 per cent. to their disruptive strength.

Hard rubber compounds are, some of them, also used as sheet insulation, especially those vulcanized with asbestos fibre. Flexibility is, of course, impossible, and sometimes such material will ignite when brought into contact with a flame. Unless the asbestos fibre is long, the sheet will crack when strained. The chief objection to these products is the presence of sulphur, introduced to hasten vulcanization, but causing swelling and blisters under heat and subsequent short circuits. $\frac{1}{32}$in. sheet vul-

cabeston will break down at about 2600 volts. Asbestos paper and millboard are not insulations, but are of fire-proofing material. Thin paper (.007in.) will be punctured under a pressure of 500 volts.

As an illustration of the variable insulating value of one of these fibrous materials, the following list is given. All were made by one company:

Thickness.	Colour.	Disruptive Strength.
.019 (1-64th in.)	Gray	4000 volts
.035 (1-32nd in.)	Red	3000 ,,
.042	Gray	6000 ,,
.051	Black	5200 ,,
.088	Red	8000 ,,
.101	Black	above 8000 ,,

Treatments and Composite Insulations.

Varnished cloth and paper are greatly valued necessities, but the day of the simple gum varnish is past. It is now generally recognized that other treatment than that of dipping in a hot bath of melted copal gum or shellac is required if insulation is to stand at a constant value. It was found that these varnishes, which flowed so smoothly and gave such high insulation resistance, soon "checked" when chilled. They are entirely suitable for instrument coils, but on a machine coil will crumble away under vibration. Moisture in the air soon finds its way through these minute cracks, and then chemical and electrolytic decomposition follow.

Asphalt, bitumen, and the other mineral pitches have also fallen under just criticism similar to that bearing upon the gum varnishes. Linseed oil, when thoroughly boiled out, has been combined in many successful varnishes. A mixture with copal applied to press board and thoroughly baked practically doubles the disruptive strength of the board. It is only when the test of time is applied that the material breaks down. Linseed oil varnish will in time oxidize and crack. It, like the gum, is acid, and must attack both metal and organic material with the usual results.

The attempt has been made to protect copper from corrosion by coating the surface with paraffin treated to withstand heat. Similar materials have also been successfully combined with resin in the preparation of a varnish which has permanent insulating characteristics. The only absolute test in this matter is that of actual service over an extended period of time under aggravating conditions. Often several layers of insulating varnishes for different purposes are desirable, particularly on a refractory machine, which has more than once burned out under the direct effect of trying local conditions. First use a non-corrosive varnish next to the coils and last of all a weather and acid proof finish.

Insulating fibre in any form is improved by application of varnish, but this advantage is lost unless the material remains plastic indefinitely, and this is the object sought by the insulating expert. Another and sometimes independent object, has been to obtain a heat-conducting and diffusing quality in the insulating fluid.

In general the purchase of quick driers should be avoided and some form of oven arranged for baking out coils and armatures. The ingredients which cause a paint to dry quickly are apt to decrease its insulating quality. One maker of insulating varnish states as a rule that there should be a disruptive strength in a good varnish of at least 1000 volts per layer of 1 mil in thickness applied 1 minute in an air temperature of 70deg. F.

In the matter of fabrics it is an advantage to use that commercially prepared by an experienced firm, as the emulsions and processes are presumably the result of expert treatment. So-called "empire cloth" is simply cambric carried through a hot oil bath, but it is difficult to duplicate its electrical strength without the special machinery used in its treatments—preliminary, insulating and drying. If unprepared cloth is bought it should be unbleached to avoid the chemical action of chlorine, and smoothly ironed to avoid minute roughness in the finished insulating layers.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

The Aussig Glocken Process for Alkali Chloride Electrolysis.

OTTO STEINER.

ELECTRO - CHEMICAL methods are generally employed in chemical industries for the sake of simplifying the operation. Purely chemical processes involve a whole series of different reactions in order to get the desired end products from common salt. The electric current, on the other hand, decomposes the salt in one single apparatus and in one single operation. The immediate products of electrolysis are chlorine gas at the anode and caustic soda at the cathode. It is only necessary to so construct the apparatus as to prevent the reunion of these two products.

For this purpose it is necessary to separate the anode liquid, in which some chlorine gas is dissolved from the cathode liquid which contains the caustic alkali. While the chlorine set free at the anode mostly escapes as gas, yet some of it dissolves in the liquid. If this anode liquid containing the chlorine then mixes with cathode liquid containing hydroxide hypochlorite will be formed. By the application of a diaphragm, it is possible to separate the anolyte from the catholyte so as to prevent the mechanical mixing of the two solutions, without preventing the passage of the electric current. But the action between the two solutions is due not only to mechanical mixing; it is also electro-chemical in nature, since the caustic alkali in the catholyte participates in the conduction of the current. The OH ions of the catholyte will travel through the diaphragm into the anolyte. In this way caustic alkali is transported towards the anode in spite of the diaphragm. In consequence of this it is impossible on a large commercial scale to manufacture highly concentrated caustic solutions by the diaphragm process without running the risk of greatly reducing the ampere-hour efficiency together with other troublesome disadvantages.

Various methods have been suggested to prevent the electro-chemical reaction between the two liquids. There are some hundred different processes aiming at this end, but only those of special simplicity have proven industrially successful This is especially the case for the Aussig "Glocken" (bell) process of the "Oesterreichische Verein für Chemische and Metallurgische Production in Aussig" (Bohemia), a description of which appeared recently in the journal *Electro-chemical and Metallurgical Industry*. This process is now used on a very large scale (about 6000h.p.) in Austria as well as in Germany.

The general principle of the process is shown in Fig. 1. An earthenware bell is suspended in the salt solution in such a way that it does not reach down to the bottom. The anode is inside the bell, the cathode outside.

The anode liquid, which has a green colour on account of its content of dissolved chlorine gas, is of lower specific gravity and fills the upper part of the bell. The colourless cathode liquid fills the part underneath as well as the whole outside of the bell.

Between both solutions is a layer of neutral solution, which remains at the same place, if the current, the content of hydroxide in the catholyte, and the content of alkali chloride in the anolyte are kept constant.

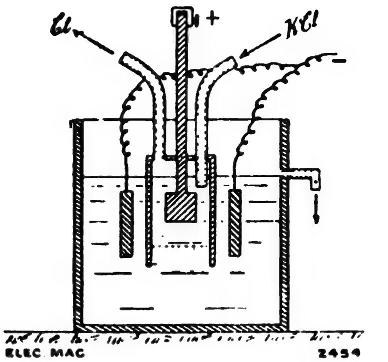


FIG. 1. PRINCIPLE OF GLOCKEN PROCESS.

This can be accomplished in continuous operation by introducing the fresh salt solution into the bell above the anode, so as to distribute it very uniformly over the whole anode surface, and by continually removing the formed caustic solution from the cathode compartment simply by overflow.

The anolyte, containing chlorine, moves inside the bell downwards in consequence of the continuous supply of fresh electrolyte. It finally passes outside of the bell, and the hydroxide of the catholyte will then react with the dissolved chlorine and form hypochlorite, which will be reduced to alkali chloride at the cathode. In practice this reaction between chlorine and hydroxide will cause a loss of 6 per cent. in the ampere-hour efficiency.

The idea of permitting the anode liquid with the chlorine to pass over directly to the cathode is rather audacious and is almost stunning at first sight, because this is exactly the thing which ought to be prevented—namely the mixing of the anolyte with the catholyte. But as a strong salt solution does not dissolve more chlorine than 0.4 per cent. of its weight, the loss in ampere-hour efficiency is very small, amounting on a large scale to only 6 per cent. On the other hand this arrangement has further great advantages. The liquid surrounding the anode is constantly maintained saturated with chloride, and the OH ions, which migrate from the cathode towards the anode, are thus prevented from reaching the anode. The reason is this: both the OH ions and the Cl ions are migrating from cathode to anode, and the part which these two kinds of ions take in the electric conduction depends, according to Hittorf, on their number and their speed of migration. If, for example, the solution at the cathode contains 12 per cent. KOH and 12 per cent. KCl, it will be found that the negative ions travelling from the cathode are almost completely OH ions.

But on their further advance towards the anode they will come into layers, which contain more KCl, and therefore more Cl ions, on account of the continuous supply of fresh salt solution at the anode. Therefore, the OH ions will gradually remain behind and the Cl ions will chiefly undertake the negative transmission of the current. At the anode itself the KCl concentration is maintained constantly at 20 per cent., so that the only negative ions moving at this place will be the Cl ions and no OH ions will reach the anode.

In expositions of the theory of the Glocken process the wrong idea is often found that the electrolyte moves inside of the bell downwards with the same speed with which the OH ions move upwards, and that it is necessary to regulate the rate of supply of fresh alkali-chloride solution in such a way that the neutral layer which forms between the anolyte containing chlorine and the caustic catholyte remains on the same place.

The technical arrangement of the Aussig Glocken process requires a construction somewhat similar to that shown in Fig. 2. The even uniform distribution of the fresh solution over the whole anode surface and its thorough mixing with the solution, which already surrounds the anode, and which is weaker and therefore of lower specific gravity, are of greatest importance. In the patents of the Aussig firm it is specified that for this purpose the anode should be made so large that it fills almost completely the whole horizontal cross-section of the cell. Only a small space of a few millimetres is left between the anode and the cell wall, and in this narrow space the rising chlorine bubbles cause an intimate mixing of the solutions.

Experiments prove that this condition alone is not sufficient, but that it is also necessary that the upper surface of the anode, or at least the exterior rim of it, should be absolutely level and horizontal. If this surface is only a little inclined all the fresh solution, being of higher specific gravity, will flow down in one stream from the lowest point of the anode surface without being distributed over the whole anode surface and without getting thoroughly mixed

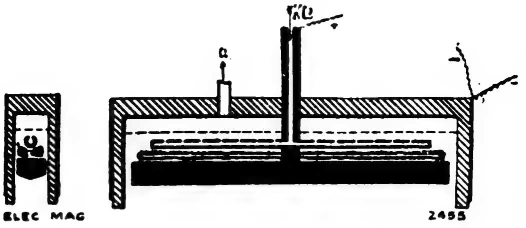


FIG. 2. LATER CONSTRUCTION OF CELL.

with all the old solution. As a result the anode liquid will get weaker in alkali chloride, OH ions will come near to the anode, oxygen will be set free, disintegration of the anode material will occur, in short we have all troubles which it is of greatest importance to avoid.

Not only the flat form but also the absolutely horizontal position of the anodes is therefore of greatest importance and every bell must be an apparatus of precision if it shall operate properly. By careful observation of this precaution Acheson graphite will prove such an excellent anode material that it will last for five years.

To sum up the advantages of the Aussig bell process: first of all we have the simplicity of its apparatus, then the high ampere-hour efficiency, the high concentration of the caustic alkali produced, and the long life of the anodes. Its disadvantage is that for a large scale of production a very great number of small apparatus are necessary, since the bells cannot be made large.

Commercial Electric Furnaces.

THE remarkable growth of the electrochemical industry in the United States was made very evident at the sixth annual meeting of the American Electro-chemical Society held during May at Philadelphia. The numerous papers read covered an extremely wide range and revealed the enormous amount of research work in hand and rapid advances made in practical applications. It is hoped to deal with some of the more important papers in a future number of THE ELECTRICAL MAGAZINE; for the present readers are directed to a description of the Colby Electric Steel Furnace, which members of the Society were privilegd to see in practical operation.

This furnace (Fig. 1) is rated at 131kva. The voltage of the single-phase primary current is 240 volts, the maximum current 540amp., and the frequency is 60. The primary consists of 28 turns of copper tube, $\frac{3}{8}$in. inside and $\frac{5}{8}$in. outside diameter, and is cooled by internal water circulation. The annular crucible which, with its contents, forms the secondary of the transformer furnace, is a one-piece crucible, $14\frac{5}{8}$in. inside and $24\frac{1}{4}$in. outside diameter, 8in. in height. The trough is $6\frac{3}{8}$in. deep, $2\frac{7}{16}$in. wide at top, and 2in. at the bottom, with a working capacity of 190lb. of steel. The current in this crucible is, at a maximum, 15,148amp. at 8.57 volts.

Ingots of 90lb. can be poured every hour, leaving 100lb. in the crucible. Fresh materials are then added at once. The fusion is complete in half an hour. The refining and killing takes the other half-hour. The steel lays very still in the mould. The ingots are very dense and homogeneous.

The present-size crucible requires 40kw. at the maximum. The current regulation is practically controlled by the amount of metal in the crucible. External control is only necessary to control the temperatures during refining and boiling out gases.

The energy used per 100lb. of metal poured varies from 27.5 to 37.5kw.-hours, according to the nature of the charge and the percentage of carbon desired in the finished product. It was stated that the pinch effect has never been observed in this furnace. The calculated resistivity of steel is of little use in calculating the amount of current required in the primary, as the section of the current track is constantly altering, due to liberated gases.

Another visit made by the members was to a very interesting exhibition and demonstration of various models of electric furnaces. This exhibition is shown in Fig. 2. The furnace at the left of the picture is a kryptol furnace, kryptol being the well-known granular carbon resistance material. This furnace is very convenient for melting 2lb. or 3lb. per crucible of metals or alloys. Plates of Acheson graphite are placed at each end of a chamber built up of refractory materials, and the crucibles are plunged into kryptol, which is packed around them. Different temperatures are obtained in each crucible by taking off the cover and reducing the depth of kryptol around the one to be heated to the higher point. The furnace consumes about 7kw., and is operated at

110 volts. By inserting resistance in the circuit the temperature may be readily controlled. Ordinary operations require current for 20 minutes when starting with cold materials.

The next furnace, No. 2 on the illustration, is an arc furnace with two electrodes, somewhat similar to the Héroult furnace which has been used for the reduction of magnetite by charcoal in the well-known tests at Sault Ste. Marie. The small experimental furnace holds 100lb. The arcs are produced between the electrodes and the slag on the top of the metal. From 300amp. to 500amp. at from 35 volts to 40 volts are used at each electrode, making the total power consumption in the furnace from 21kw. to 40kw. This furnace has been used experimentally in reducing iron ores. Fine grade steel has also been produced by starting with pure concentrates and subsequent refining in an induction furnace.

The third furnace shown is a single-electrode arc furnace of the type used by Siemens, Willson, Héroult and others. In this case the crucible and its contents are connected to one pole of the circuit and the movable electrode to the other. The current used in this model is from 300amp. to 500amp. at 35 volts to 50 volts, which represents a total capacity of from 10.5kw. to 25kw. This model has been used principally in the production of carbides of various metals. The furnace was shown in the course of making titanium carbide. The character of the arc was very noticeable. The furnace may, of course, be used both with alternating current and with direct current.

The fourth furnace is a barium-chloride furnace. It is specially adapted for use in hardening and annealing, and has met with considerable success in America and also in European countries. Samples of high-speed steel were hardened in this furnace; these showed that there is absolutely no effect on the surface of the steel and that the pieces come out as pretty a finished product as can be imagined.

The electrodes of the furnace are of wrought iron. The bath consists of fused barium chloride for temperatures above 1000deg. C. For lower temperatures a mixture of chlorides of barium and calcium is used. The size of the bath is $7\frac{7}{8} \times 7\frac{7}{8} \times 10\frac{3}{8}$in. It takes about half an hour to heat the furnace up thoroughly, and the power consumption ranges from 8.5 to 12kw. A wide range of temperature is possible by adjusting the voltage. Since the current density in the molten bath is practically uniform the temperature within the bath, except in the thin layer in the upper surface, is found to be very uniform. An

FIG. 1. THE COLBY ELECTRIC STEEL FURNACE.

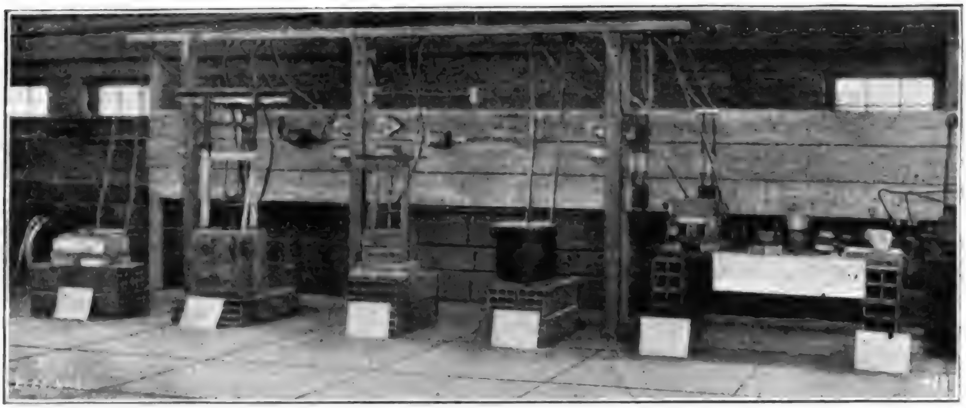


FIG. 2. VARIOUS TYPES OF ELECTRIC FURNACES.

illustrated description of this type of furnace as produced by the Electrical Company, Ltd., appeared in THE ELECTRICAL MAGAZINE of October last year.

In coal or gas heating of articles made of high-speed steel for tempering, sharp corners are broken down and sizes are altered by scaling due to oxidation. On the other hand, articles treated in this electrically-fused chloride bath come out perfect. Articles requiring to be heated to a high temperature, such as high speed tool steels, can be immersed in the bath without oxidation or other chemical action and can be quickly brought up to the required temperature. The field for the application of this furnace will doubtless become very large and important.

The Commercial Production of Electrolytic Disinfectant.

THE annual report for the past year by Dr. F. W. Alexander, the medical officer of health to the borough of Poplar, contains a valuable description of a continuous process of producing an electrolytic disinfecting fluid, and figures of the operating costs of a highly successful plant he has provided for the borough.

Dr. Alexander reports that the step initiated has proved itself overwhelmingly satisfactory from every point of view, particularly that of the public health of the district during the period for which the plant has been at work.

The system adopted at Poplar is to mix a certain quantity of fluid, solution of chlorides of sodium and magnesium, in an elevated tank, and then to allow this fluid to pass through a small regulating tank into a series of four double troughs, or cells, placed one above the other, so that the liquid descends continuously by gravity. Each trough is divided laterally by a partition, and in each of the two divisions five distinct "elements" (consisting of one positive and two negative plates) are suspended. The positive plates are of thin platinum wire wound upon slate slabs, and the negative plates are of zinc. There are thus four troughs, each containing ten "elements," or forty cells in all. The liquid passes through this series and is finally discharged into a carboy. A bottle arranged at the side of the tier of cells supplies the sodium hydroxide used as a preservative, which flows drop by drop into the carboy as it is filling, and serves to neutralise free hypochlorous acid. As the liquid passes through the troughs it is subjected to the action of a regulated current of 15 to 17 amperes at 230 to 250 volts, being 5.7 to 6.2 volts per cell. During the run the liquid in the carboy is thoroughly stirred by means of an ebonite rod provided with rubber flaps.

The objects aimed at to make the working of the apparatus and the manufacture of the fluid become simple and automatic were as follows:—(1) To see at a glance whether the apparatus is working properly. This is accomplished by a gauge glass in front of the large tank, and another gauge glass on the little supply tank, the first to show the quantity of salt liquor capable of being acted upon, and the second to show if the liquor is running properly into and out of the small supply tank, as the chloride of magnesium

contains impurities which are likely to block up the valve of the small cistern and the taps leading to and from the same. (2) The liquor to be electrolysed in the large tank had to be stirred from time to time to keep the mixture of an equal gravity throughout. A large broad drilled plate of galvanised iron is used, one end of which is lifted up by means of a hand chain leading over pulleys to the ground. (3) It is necessary to govern the electric current, which is taken direct from the mains, on account of the density of the salt mixture to be acted upon varying from time to time owing to temperature changes and consequent changes in conductivity. This difficulty is got over by a current regulator. (4) To prevent shocks and waste of fluid whilst changing the carboys, a special glass tap has been provided. (5) To prevent loss of available chlorine the solution of sodium hydroxide drips into a specially blown carboy at the same time as the fluid is running into it, and the two fluids are mixed with an ebonite stirrer with rubber flaps inserted through an aperture in the neck of the carboy. (6) So far as oxychlorides are concerned, the apparatus in ten months had only been taken to pieces and cleaned twice. Every day, after working, the electrolysers are emptied, and the fluid which is run out is kept to re-charge the electrolysers. The electrolysers, after being emptied, are washed out by means of a hose, and then until the next working are kept filled with water, which softens any deposit formed upon the electrodes. Before starting work the electrolysers are emptied and washed out again.

During twelve months (the apparatus was installed at the beginning of February, 1906), some 17,000 gallons of fluid have been manufactured of a strength between 4.0 and 4.5 grammes of available chlorine per litre.

The fluid has been issued to the public in pint bottles from the depots. For watering the roads, market-places, &c., the Works Department has been furnished with 9116 gallons at a charge of 1d. per gallon. The Poplar Guardians for their institutions, and the managers of the sick asylums, have been supplied with 568 gallons during the last four months of the year's working for which no charge has been made.

There have been required 2543 units of electrical energy at 1½d. per unit, four tons of salt have been used at 24s. per ton, and two tons of chloride of magnesium, at £3 17s. 6d. per ton, caustic soda costing £4 0s. 8d.; water, together with that used for washing out the electrolysers and for other purposes, £2 15s. 8d., including meter rent.

COST OF CARBOLIC DISINFECTANTS.

For the Years 1903, 1904, 1905.

	1903. £	s.	d.	1904. £	s.	d.	1905. £	s.	d.
Carbolic fluid disinfectant	184	17	1	216	17	5	242	0	0
Carbolic powder disinfectant ...	52	1	6	59	0	6	72	2	0
First total ...	236	18	7	275	17	11	314	2	0
Bottles	109	3	7	127	15	4	118	19	3
Corks	12	10	0	18	15	0	19	15	10
Labels	3	12	0	5	15	6	3	15	0
Bags	16	18	4	20	12	6	25	17	6
Cotton Waste ...	0	14	6	1	6	0	1	3	0
Wages, making up and issuing ...	284	5	9	321	4	8	373	12	2
Cartage		—			—		5	0	10
Second total...	427	4	2	495	9	0	548	3	7
Full totals ...	£664	2	9	£771	6	11	£862	5	7

COST OF ELECTROLYTIC DISINFECTANT, 1906-1907.

Initial Outlay—

	£	s.	d.
Plant, which is indestructible with the exception of the forty zinc electrodes, which may occasionally have to be replaced at a cost of 7s. 6d. each, after some years of wear (M. Hermite) ...	325	0	0
Fittings, &c. (Electricity Department)	71	7	11
Sundries, structural (Electricity Department)...	6	6	11
Sundries (Electricity Department)	4	6	11
Structure of Depôt (Works Department)... ...	120	6	6
Sundries	32	4	1
Carboys...	23	16	7
	£583	9	2

MANUFACTURING DISINFECTANT.

February, 1906, to February, 1907.

	£	s.	d.
Electricity...	15	17	10
Salt	4	6	0
Chloride of Magnesium	7	18	9
Caustic Soda	4	0	8
Water (manufacturing disinfectant)	0	17	0
Wages (manufacturing disinfectant)	100	0	0
,, (packing, delivering, and issuing)	307	12	7
Testing Reagent	215	3	0
Bottles	97	12	1
Corks	19	11	8
Paraffin Wax for Corks	1	15	0
Labels...	10	7	6
Water (washing, rent, and meter)	1	18	8
Cotton Waste	0	11	0
Cartage	23	18	5
Supplying Electric Light	2	15	0
Paste	0	9	6
Rent and Supervision (no loss to the Borough Council, as the amount is paid to the Electricity Department), per annum...	30	0	0
Insurance—Fire	1	5	0
,, —Burglary	1	12	0
	£635	13	11
Less receipts from Works Department, 9116 gallons, at 1d. per gallon	37	19	8
	£597	14	3

In comparing the expenditure of the year 1906 with that of 1905 it will be seen there has been a saving of £265, and if the sum of £30 paid to the Electricity Department as rent and supervision be not taken into account, there has been brought about a saving of nearly £300, and this amount does not include any charge for the quantity furnished to the Guardians, as the fluid has been supplied to them gratis.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

A New Reversible Ventilating Fan.

Blackman Export Company, Ltd.

The Blackman Fan, of which it is stated there are now nearly a hundred thousand at work, is so well known that the following particulars concerning a new patent reversible type will be of general interest.

The Double Blackman, as this new fan is called, is arranged either with pulley for belt driving, or with motor as for the electric drive as illustrated.

It will be seen that the time-honoured broad blades have been discarded in favour of a larger number of narrow blades of strip metal. Each pair of blades is made from one piece of strip metal bent into the shape of a triangle, the base of which is fixed obliquely on the fan boss, so that the eight pairs of blades form two fan wheels, both inclined inwards and joined at the periphery. There are sixteen blades in this particular fan, but owing to their being in pairs and staggered there is a wide clearance between them ; none of them over-lap in such a way as to impede the course of the air, and so the highest possible mechanical efficiency is obtained.

Two main considerations govern the design of every propeller so as to obtain a high standard of efficiency (the largest possible output per horse-power consumed by the fan). On the one hand, the blades should be set at such an angle that they do not carry the air round with them, causing excessive swirling of the air on the discharge side of the fan. On the other hand, the angle should be such that the blades recede rapidly enough from the advancing air to avoid the broad backs of the blades striking or being struck by the air


The Electric Double Blackman.


Belted Type of Double Blackman.

which is travelling at right angles to their line of motion and deflecting it from its course with the consequent waste of power. But the best angle for the one purpose is the worst for the other, so that with broad-bladed fans no alternative is left but an inefficient compromise. There is another point of great importance which materially affects the efficiency of a propeller: the whole of the air should travel at the same velocity through every part of the fan, so that its central portion is as effective as the other part. The velocity of each particle of air through the fan is approximately proportional to the pitch of the fan in conjunction with the velocity at that part of the fan's radius where the particle enters, but as the velocity decreases from maximum at the

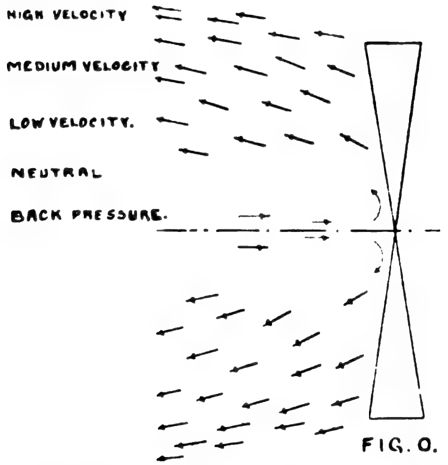


FIG. O.

circumference to zero at the centre of the fan wheel, anything like the corresponding variation in pitch of blades is, of course, impossible whatever curves may be adopted.

As a matter of fact, the velocity of the air through any wing fan may be 1000, 2000 or 3000ft. per minute at the periphery, but near the centre there is no appreciable forward velocity and frequently a backward one as shown in the diagram Fig. o.

The difficulties attending broad blades are considerably accentuated in propellers of the reversible type, because the best curve of a blade for forward action becomes the worst when the motion of the propeller is reversed.

In Fig. 1 the curve A-B represents the cross-section of a fan blade and D-E the axis of the fan; the blade moves from right to left.

FIG. 1.

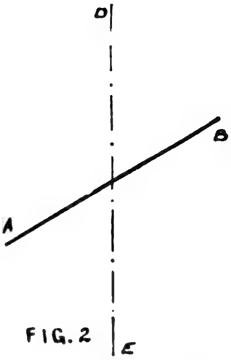


FIG. 2

Such a blade would give good results, meeting the air at A without shock and delivering it in the direction D. But imagine this blade to be run in the contrary direction, *i.e.*, to the right; it is evident that the face B would beat the air with considerable force and, on account of the steep angle, raise the velocity of the air very rapidly; then, letting the velocity quickly fall, it would push the air in the direction E, having expended unnecessarily a great deal of power in the operation. In the case of a flat blade as shown in Fig. 2, there is more shock and a more rapid compression of the air than is the case with the blade shown in Fig. 1 when run to the left, and less than with the same fan run to the right, but the friction across the broad blade and its stirring action induces swirls and eddies in the air which are destructive to high efficiency. To reduce shock in reversible fans, blades have been tried bent at the edges, as in Fig. 3—an ingenious compromise which, however, on account of the broadness of the blades, does not get rid of the friction and swirling, although the shock is minimised by the arrangement. A step in another direction was to cut the middle out of the blade as

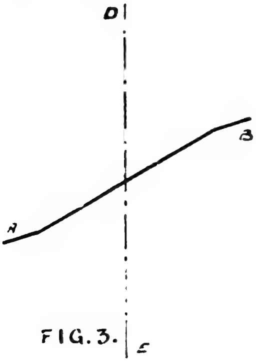


FIG. 3.

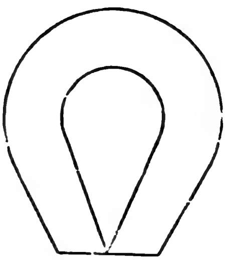


FIG. 4.

shown in Fig. 4. By this arrangement a blade is produced similar to Fig. 2, but with a clearance through the centre (Fig. 4A shows such a blade in section). But this design, although a step forward, leaves the chief part of the evil unremoved, because at the outer end of the blade the solid part remains, and consequently there is a surface of considerable area, just where the velocity is greatest, vigorously stirring and beating the air. Further objections to this class of blade are its expense, as it must be cut out of sheet metal, and that the blade area is decreased by the removal of the central portion so that the work done is less, necessitating in consequence an additional number of blades for which, however, there is not room without obstructing the air passage.

Fig. 5 shows in diagram form two adjacent double blades (in section) of the new Double Blackman; it is obvious that, by a very simple device, the shock is avoided in the same way as in Fig. 3, and by leaving the central portion of the fan quite free, the swirling action is minimised much more effectively than in Fig. 4, while the faults of both those constructions are absent, with a corresponding improvement in efficiency, which is the highest possible, because there is no point where power is wasted.

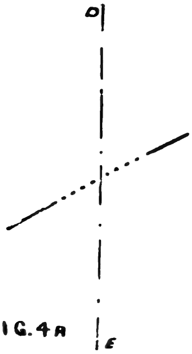


FIG. 4A

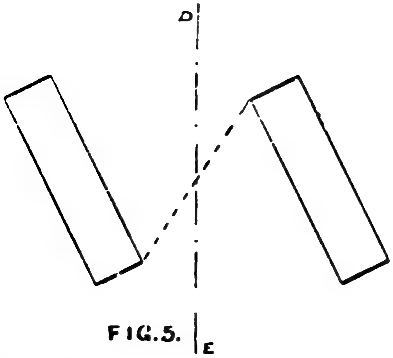


FIG. 5.

The narrow, low pitched blades of this fan do not cause the air to assume the hollow cone shape illustrated in Fig. o, but, on the contrary, and this is an important and interesting feature, the centre of the new fan is as strong as any other part of the fan wheel, so that it feeds equally well all over the face. This advantage results from the peculiar arrangement of the double row of blades, which, as explained, form two fans working in series, the one supplementing and reinforcing the other. Both sets of blades, those behind and those in front, are run at the same speed, so that, besides hastening the velocity of the air at the periphery, the second set of blades finds work to do in drawing air through the centre of the first set, thus strengthening the centre and equalizing the velocity of the air through the whole fan. Moreover the second row of blades straightens the air current and so produces a discharge which is absolutely axial in direction.

The natural consequence of this equal feeding all over the face of the fan combined with its axial discharge is that the

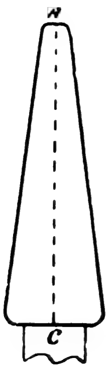


FIG. 6.

wheel may be run in a tube of its own diameter without any enlargement around its periphery.

It will be noticed that the blades incline inwards, each forming the hypothenuse of one of two triangles having a common base A-C (Fig. 6) and therefore the blade lengths on both sides are in excess of the distance A-C, so that the feed surfaces of the blades are extra long and at the same time the area through A-C (where the airway is most restricted) is left quite free from any obstruction. Notwithstanding the triangular formation of the blades, the fan projects but very little on either side of the wall or partition to which it is fixed.

The particular advantages which the new Double Blackman offers to the user are briefly :—

The fan is reversible. both sides being identical in every respect, so that the direction of the air current can be reversed without loss of efficiency by running the fan in the opposite direction ; it is the most efficient reversible fan on the market, *i.e.*, it moves the greatest volume of air with the least consumption of power ; it will do its work inside a tube without any air space around its periphery; the fan takes little room, as it projects but little on either side ; it is provided with self-adjusting antifriction thrust bearings at each end of the spindle, and therefore does not overhang ; the blades are separately renewable.

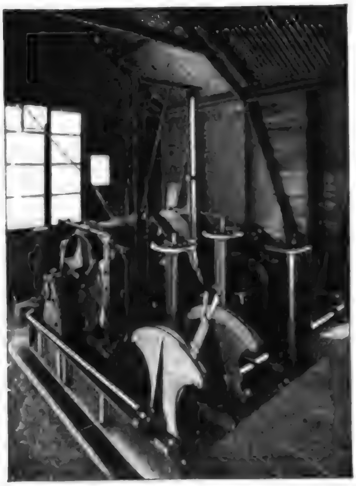
Chemical manufacturers, dyers, explosives manufacturers, and others, who, on account of acid fumes, require fans with blades made of special material and easily renewable, will particularly welcome this new fan, because its blades can be bent from strips of any malleable metal or alloy; and when worn out, any blade can be renewed in a few minutes instead of a complete new fan-wheel having to be obtained.

Electric Winding Engine.

Clarke, Chapman & Co., Ltd.

THERE is still great diversity of opinion as to the merits of electrical winding engines, that is particularly of those used for main shaft service in collieries ; but there is little doubt as to the extreme utility and economy of small gears of this class. Large numbers of small electric winding gears are in constant successful use, and where an electric supply is available the mining engineer can introduce these gears with perfect confidence as to their reliability and general good performance.

The illustration below shows one of these smaller gears, as manufactured by Messrs. Clarke, Chapman & Co., Ltd., and which



CLARKE, CHAPMAN WINDING GEAR.

has now been working for some time most satisfactorily. This particular gear deals with an out-of-balance load of 1½ tons at a speed of 250ft. per minute, from a depth of 720ft. It is driven by a three-phase slip-ring motor through double reduction spur gearing. Each drum is coupled to the shaft by means of a claw clutch, and is provided with its own post brake ; thus either drum can be worked independently, if so desired. The brakes are operated by foot levers, but each brake is further provided with a pillar and screw gear to hold it on permanently when desired ; this allows of great flexibility in working, so that the load on one drum may be held suspended in the shaft while the other drum can be handling work in the normal manner.

Exhibition Stands.

A. Elmes & Co.

THERE can be no doubt that one of the first and most important aims of an exhibition is to secure a stand which shall be attractive and in thorough keeping with the nature of the goods to be shown. In these days of frequent exhibitions the

design of stands has come to be quite a fine art, and as a business it rests practically with one or two firms who have made a distinct speciality of this class of work. The record of Messrs. Elmes & Co. indicates remarkable progress. They claim to be the oldest established firm of exhibition stand fitters in London, and are constantly extending their volume of business. Founded upwards of a quarter of a century ago, they received a special award for work done at the Manchester Exhibition in 1895; they fitted up the entire exhibition, and for that purpose took large works in Manchester itself. In the year 1900, Messrs. Elmes fitted the whole of the Educational Exhibition held at the Imperial Institute. Amongst other exhibition contracts may be mentioned those of Birmingham, Glasgow, Crystal Palace, Olympia, Agricultural Hall, &c. The present Irish International Exhibition contains many examples of this firm's work, which speak for themselves as to their artistic and attractive design. The largest stand ever erected at any exhibition in this country for one firm was set up by Messrs. Elmes, and included the whole of the minor hall of the Agricultural Hall, London.

That this company is more than holding its reputation is evident from the various extensions which are constantly required in their shops and warehouses. Although they have just completed a new stores building, this is proving insufficient, and only within the past few weeks they have acquired another large freehold site from which the old buildings are being removed and a new factory and store, in itself sufficiently large for exhibition purposes, is to be built. The business of exhibition fitters does not merely consist of the design and erection of stands; every requisite in the way of linoleums, carpets, and general furniture, desks, files, and showcases, are all supplied by the firm.

An example of recent work done by Messrs. Elmes is shown in the illustration below, which is a view of the stand of THE ELECTRICAL MAGAZINE intended for the forthcoming Engineering and Machinery Exhibition to be opened at Olympia next month.

THE STAND OF "THE ELECTRICAL MAGAZINE" FOR THE ENGINEERING AND MACHINERY EXHIBITION, OLYMPIA, SEPT. 19TH TO OCT 19TH, 1907.
Designed and built by Messrs. Elmes & Co., 347, Upper St., Islington, London, N.

System in Business.

The Stolzenberg Patent File Company, London.

ORGANISATION is the secret of business success in nine cases out of ten, and organisation is often the most neglected factor in otherwise well-equipped businesses which have expanded so quickly that they have grown out of the grasp of the controlling hand. The British business-man is a long way behind both America and the Continent in office method, which is to the huge business as is a good lubricant to running machinery.

The question of filing is a bugbear to the busy man. What is the ideal filing system? The ideal filing system is one which will give every paper, or any paper, letter, document, or memorandum, relating to any one matter in the office, a place in the office, where it may be found at once with absolute certainty. Not nine times out of ten—it is the tenth time which wrecks most filing systems, and reduces the office to despair. The busy business man, having reasoned so far, sighs wearily. He remembers years of experiments and their result—utter inadequacy—and he surmises, idly, that the dream of filing perfection must go the way of all ideals, and be broken on the wheel of everyday experience.

Yet there is a filing system which it is claimed actually brings into the office the conditions laid down in the foregoing. The Stolzenberg System has been tested in the light of the heaviest demands, and has not yet revealed a weakness. Government departments, huge railways, municipal undertakings, educational organisations, and great business concerns — the great commercial growths where documentary detail silts up like sand on the seashore—have this system in operation, and their opinions are couched in high terms of recommendation. And, great as the capacity of the system is to cope with the exacting demands of large business undertakings, so elastic is it that it will maintain the same order for the private, literary, social, or business worker. It is said to be the one system which promptly supplies an answer to every puzzle which office routine daily gives to the organiser, and which is not held up by the thousand daily variations from a set office rule, which have so far brought many an excellent theoretical filing system to a standstill. Every business or professional man who flounders through the day's work in a muddle of papers and memoranda should investigate this system at once, and see how far this favourable estimate of its capacity is borne out in the light of the individual needs of any business-man.

The basis of the Stolzenberg System is the unit—a unit of strong-backed covers containing a stout holder which effectively keeps every paper fixed firmly in its place. The units cost from 2d. to 6d. each, according to quality. It seems such a trivial matter—this unit as a basis on which to build a huge filing system adequate to the needs of a great railway company. It is so simple a unit in comparison with the cumbrous clips and clamps which have superseded the still more childish scrap-book. But a moment's reflection will show any business-man open to conviction that the essential feature of successful filing lies in the simple unit. This unit will bind hundreds of papers neatly and securely, fitting perfectly flat, and taking up the smallest amount of room. The underlying idea is to use one file for one client, and systematically file everything under that name, in the order of its receipt, together with the copy of the reply. The result is that whenever that client's affairs pass under review, there is a neatly-bound booklet containing the whole history of his transactions in a handy form. A staff of clerks have not to be sent searching through cumbrous files, taking out a letter here and a letter there, or bringing a pile of filing or copying books to crowd the principal's desk.

If one had only one client, or one series of transactions, one file would be needed. If there were fifty thousand clients and fifty thousand series of transactions, fifty thousand files would be necessary. For miscellaneous or casual correspondence special arrangements are made in uniformity with the spirit of the system. The smallest or the largest business will find the Stolzenberg System adequate. As the business of filing grows more complicated and extensive, six distinct colours of files can be used systematically to indicate different departments of the business, or sub-divisions, such as geographical districts, enabling immediate reference to any file out of tens of thousands. Throughout, the principle of the system remains the same—the individuality of the unit—and the papers of every client, or case,

or series of transactions are confined to one file, which can be turned up at the shortest notice, giving with absolute certainty just the papers needed. Where the files multiply into the hundreds, special provision must be made for storing them, and the Stolzenberg Company has specialised a cabinet adapted to the development of its unique filing system. Here, again, the unit idea is the basis of the system. These cabinets are well made, silent, and labour-saving; they open and shut automatically; there is no limit to their effectiveness, and their appearance gives to the office a tidy, businesslike look, and a substantial atmosphere which make the best of impressions on clients and callers generally.

The Stolzenberg Company are responsible for several labour-saving, systematising, office ideas, which modern business-men find indispensable, including the Stolzenberg Ready Sorter, Follow-up Systems for Advertisers and Business-men, Card Index Systems, &c., all making towards one end, *i.e.*, to save the time of the principal so that he is always in a position to get through the day's work quickly and accurately, unhampered by incessant worry over detail. Mr. Kayser, the proprietor, has made filing a life-long study, and is willing to give an intelligent demonstration of his system to any *bona fide* inquirer.

Multi-Tone Vibrating Transmitter.

The India-Rubber, Gutta Percha and Telegraph Works Company, Ltd.

A recent introduction of the Silvertown firm is a telegraphic transmitter suitable for either acoustic, visual or recording receivers. Known as the "Raymond-Barker" multi-tone vibrating transmitter, the instrument is a novel development of the Cardew vibrating transmitter, and enables the principle to be utilised for codes made up of two notes, three notes, or any number of notes. The only receiver required for these multi-tone acoustic signals is a single telephone, although several telephones may be joined up if so desired. For the reception of visual or recorded signals respectively, a mirror galvanometer, or a Kelvin syphon recorder, may be used, the received signals emanating, in this last-mentioned case, from a two-tone transmitter sending positive and negative undulatory signals to the line.

Multi-tone transmission is not wholly unknown, but the new system is a distinct improvement on older devices, utilising, as it does, the Cardew vibrator effect, namely, current undulations of comparatively low potential accompanied by super-imposed spurts of higher potential and extra current. The electrical impulses utilised are not alternating, and are not, therefore, self-neutralising in their resultant effect on any ordinary current detector. The impulses are undulatory, but owing to the cumulative effect of extra current, and other conditions, these are endowed with a distinct resultant bias, either positive or negative.

The instrument enables any two tones to be given respectively—at the operator's pleasure—a positive or a negative resultant bias, thereby producing on any electro-capillary receiver, or on any current detector such, *e.g.*, as a Kelvin syphon recorder, those equal-time-value reversal signals generally known as constituting the syphon recorder code. The two-tone reversal transmitter makes the equal-time-value reversal code applicable to acoustic signals, *e.g.*, with telephone receiver; to signals visual but ephemeral, *e.g.*, with the mirror speaking galvanometer as receiver; and to recorded signals, *e.g.*, with syphon recorder as receiver.

The two-tone transmitter giving undulatory impulses of + or — bias offers the following advantages over the single-tone principle:—

(*a*) Owing to the fact that, in the equal-time-value reversal code, the "dot" and "dash" signals are of equal duration, whereas in the Morse code the "dash" is three times the length of the "dot:" the former system of signalling is about 36 per cent. faster than the latter.

(*b*) The two-tone acoustic system, with its two clearly distinguishable notes reproduced in the telephone, has been proved in actual practice to be more easily read in the prevalence of telegraphic cross-talk on the wires than Morse vibrator signals of short and long sounds of similar pitch.

(*c*) Signals over an aerial wire from the two-tone transmitter to the telephone or other receiver can be recorded, in equal-time-value reversal signals, on a small syphon recorder. Such an arrangement under certain conditions would be of great value, for

example, in army work when headquarters in the field may wish to effect and retain permanent record of all out-going vibrator messages despatched to outlying points.

In general practice the two-tone transmitter may be adopted, although an excellent fast secret code for military or naval purposes may be devised, using a combination of from one to three different notes. In this case a triple key and a three-tone transmitter would be used with a single telephone receiver. Two out of the three tones could at any time be used to transmit recorder signals.

The new apparatus, with a battery of six Leclanché cells, has been found to work perfectly in Brazil over nearly 2000 kilometres of aerial line, with the two notes sounding clearly in spite of loudly audible Morse cross-talk from parallel wires; the addition of 100,000 ohms to the line circuit in no way interfered with the reception of good signals. The apparatus is thoroughly suitable for working over very faulty underground lines, and could be used in cases where it is desirable—as in military operations—to signal over considerable lengths of bare wires laid direct on the ground. The two vibratory impulses transmitted from the two-tone apparatus are arranged to be of opposite electrical sign, so that when a Kelvin mirror or recorder is used as receiver on a cable or other telegraphic circuit, the + and — impulses produce good mirror or recorder signals. These recorder signals under certain conditions are more clearly defined than those produced by ordinary battery currents from a reversing key.

The use of the two-tone transmitter at a shore station in conjunction with a Gott fault-finder held on a cable-ship against a hooked but (as yet) uncut cable would, by the diverse sounds imparted respectively to "dots" and "dashes," cause the signals in the ship's telephone to be readable, whereas under like conditions the ordinary method of cable transmission would evoke in the ship's telephone signals which, owing to similarity of "dot" and "dash" sounds, would be quite unintelligible.

If only acoustic signals, with telephone receiver, be employed, one battery of from four to twelve Leclanché cells will suffice. If opposite-sign signals be required for mirror or recorder working, a double or split battery is employed.

New Catalogues.

Wires and Cables.—THE ARMORDUCT MANUFACTURING COMPANY, LTD.—Price-list W729 covers a complete range of pure and vulcanised india-rubber insulated wires and cables, aerial cables, bell and telephone wires, flexible light cords, shot firing cables, motor-car cables, insulating materials, &c. For the convenience of customers a private telegraph code is included and also a very complete reference table giving data as to conductors. This latter gives comparison of wire gauges, solid and stranded equivalents, current capacities, resistances, &c.

Transformer and Switch Oils.—THE SILVERTOWN OIL STORAGE COMPANY, London.—An interesting folder has been sent us in the form of a large coloured diagram illustrating the results of tests as to the dielectric strength of this Company's oils. The tests were made by Mr. J. H. Bolam, of Bristol. The oils are refined in this country and are claimed to possess special merits for insulation service.

Continuous-current Motors.—WRIGHT AND WOOD, LTD., Halifax.—A large postcard giving illustrations and prices of a line of protected-type motors ranging from ½b.h.p. to 30b.h.p

Aluminium Conductors.—THE BRITISH ALUMINIUM COMPANY, LTD.—A long printed list of some of those American firms who use aluminium conductors, giving details of the powers so transmitted, voltages, weights, and sections of conductors. A second leaflet illustrates the several types of joints used for aluminium circuits. The senders advise that they are supplying large and increasing quantities of alumiuium bus-bars, and solid and stranded conductors to well-known firms.

Electric Fans and Accessories.—BAXENDALE & Co., Manchester.—Illustrated price-list of small electric fans for public supply or battery circuits. The list includes table fans, port-hole fans, those for ceiling suspension and of the box blade type. Accessories as listed include automatic air valves, batteries, regulators, and starters. Separate lists give illustrations and prices of bell wires and detail apparatus. A price sheet of "Kohinoor" arc lamps has also been issued by Messrs. Baxendale.

Meters.—SIEMENS BROTHERS DYNAMO WORKS, LTD.—Under this title Messrs. Siemens have produced a neat little handbook (Pamphlet P. 1) giving fully illustrated descriptions of, and technical data concerning their ampere-hour and watt-hour meters; also several types of portable testing instruments and small pressure and current transformers for instrument circuits.

Renold's Silent Chain Gear.—HANS RENOLD, LTD., Manchester—The Renold's chain for high-speed driving is rapidly gaining popularity and should certainly be considered by all engaged in the arrangement of electric power installation. The new catalogue issued by Messrs. Hans Renold is a highly interesting and very complete treatise of its subject. The fullest information as to construction, application and operation of the chains and sprockets are given, also data as to powers and speeds. The book should be in the hands of every power engineer and all who have not a copy should avail themselves of Messrs. Renold's offer and write them for one.

Electrical Mining.—GOODMAN MANUFACTURING COMPANY, LTD., Cardiff.—Under this title is published every month a little magazine which has acquired considerable popularity amongst mining engineers in this country. It is issued gratis by the Goodman Company to interested mining men. The contents of the current issue include: The Use of Locomotives in Gathering; The Automatic Gathering Reel; Current Control on Gathering Locomotives; Machines in Coal Mining; &c.

Aluminium Cables.—JOHNSON & PHILLIPS, LTD.—We have received the advance proof of an attractive booklet entitled "Paterson's Aluminium Electric Cables—a Revolution in the Price of Electrical Conductors;" in forwarding which Messrs. Johnson & Phillips give some interesting remarks as to the development of the use of aluminium as a commercial electrical conductor. Many of the difficulties which previously have prevented aluminium being used with success have now disappeared; formerly the makers of aluminium were unable to produce a practically pure metal, which had the effect of lowering the conductivity. Now, however, the average commercial aluminium has a purity of about 99.6 per cent. As the production of aluminium has increased the price has decreased. From the statistics it is found that the world's output of aluminium in the year 1888 (when Roscoe read a paper before the Royal Institution) was 50 tons per annum; the combined production for the year 1901 was somewhat more than 5000 tons, and no doubt since then it has been considerably increased.

Even after taking into consideration the recent fall in the price of copper, aluminium stranded wires of a conductivity equal to copper can be supplied at a price showing a considerable saving when compared with the price of a copper conductor. A further advantage the use of aluminium has for overhead transmission lines is that fewer and lighter poles may be used, and also when the question of transport is a point to be considered the saving is frequently considerable owing to the lightness of the material.

Messrs. Johnson & Phillips are now prepared to quote prices for either insulated or bare aluminium conductors and are prepared to give guarantees as to the purity and conductivity of the metal. They advise that they will be pleased to send a copy of the booklet to anyone interested, and all electrical men desiring to keep well up to date should take advantage of the offer.

Drawing Instruments and Materials.—A. G. THORNTON, LTD.—A number of leaflets and folders, listing apparatus and materials to meet the draughtsman's every-day requirements. Special instruments such as suspension levels, chronographs, and clinographs, and also modern electric copying frames are included in the series.

Controllers for Printing Machine Motors.—ADAMS MANUFACTURING COMPANY, LTD.—Descriptions of installations in which the well-known "Igranic" systems of motor control is used for printing press operations. The plant of the *Derby Daily Telegraph* is driven by 20h.p. and 30h.p. motors supplied by Messrs. Newton Bros. and the "Igranic" controllers used give a range of speed from 15r.p.m. to 330r.p.m. and a precision of control which is highly spoken of by the users.

Light in the Country.—R. J. NICHOLSON & CO.—A revised edition of an artistic pamphlet under this title has been produced setting forth the merits of the "Ideal" petrol electric sets for private installations.

Literary Notes.

The next issue of THE ELECTRICAL MAGAZINE will contain a complete Literary Section, which will include Reviews of all recent Electrical and Engineering Books, Publishers' Announcements, &c., in addition to an extended and up-to-date list of the Practical Works and Text-books we recommend for the student and practical worker. This is the time of the year when the close study of winter is resumed and when the majority of new books are published. Readers should derive much benefit from the reviews and lists which will appear in our September number.

Amongst the more important books recently received are the following:—

Practical Coal-Mining. EDITED BY W. S. BOULTON, B.SC., F.G.S., VOL. 2. (LONDON: THE ELECTRICAL PUBLISHING CO., LTD., 4, SOUTHAMPTON ROW, W.C. TO BE COMPLETED IN 6 VOLS. PRICE 6s. EACH NET.)

Modern Mining Practice. EDITED BY GEORGE MITCHESON BAILES, M.E., M.I.M.E. VOL. 2. (LONDON: THE ELECTRICAL PUBLISHING CO., LTD., 4, SOUTHAMPTON ROW, W.C. TO BE COMPLETED IN 5 VOLS., PUBLISHED QUARTERLY. PRICE 10s. 6d. EACH NET.)

The Progress of Electrical Enterprise. REPRINTS OF ARTICLES FROM THE ENGINEERING SUPPLEMENT OF *The Times*, ON THE BRITISH ELECTRICAL INDUSTRIES. BY E. GARCKE, M.I.E.E. (LONDON: ELECTRICAL PRESS, LTD., 37-38, STRAND, AND 1, BUCKINGHAM PLACE, W.C. PRICE 1s. NET.)

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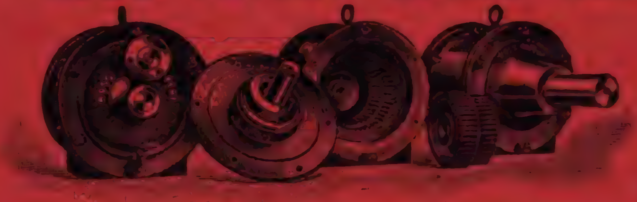

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Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Frank Suter and Co., Ltd., 66, Berners Street, London, W.

Conveying and Elevating Plant.
Babcock and Wilcox, Ltd., Oriel House, Farringdon Street, E.C.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Conveyor Belts.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Cotton Belting.
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Ed. Bennis and Co., Ltd., Little Hulton, Bolton.
Thos. Broadbent and Sons, Ltd., Huddersfield.
Craven Bros., Ltd., Osborne Street, Manchester, and at Reddish.
Temperley Transporter Co., 72, Bishopsgate Street Within, London, E.C.

Destructors (Refuse).
Meldrum Bros., Ltd., Timperley, Manchester.

Drills (Mining).
Armorduct Manufacturing Co., Ltd., Farringdon Avenue, London, E.C.
Corlett Electrical Engineering Co., Ltd., Wilcock Street, Wigan.
John Davis & Son (Derby), Ltd., 27, All Saints' Works, Derby.
Diamond Coal Cutter Co., Stennard Works, Wakefield.
Goodman Manufacturing Co., Ltd., Bank Buildings, St. Mary Street, Cardiff.
Hardy Patent Pick Co., Ltd., Sheffield.

Dynamos and Motors.
British Electric Plant Co., Ltd., Alloa, N.B.
Crompton and Co., Ltd., Salisbury House, London, E.C.
Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Electromotors, Ltd., Openshaw, Manchester.
General Electric Co., Ltd., 71, Queen Victoria Street, London, E.C.
J. H. Holmes and Co., Newcastle-on-Tyne.
India-Rubber, Gutta-Percha, and Telegraph Works Co., Ltd., 106, Cannon Street, London, E.C.; and Silvertown, E.
Industrial Engineering and Motor Co., Ltd., 12, Exchange Street, Manchester.
Maschinenfabrik Oerlikon (G. Wüthrich), Oswaldestre House, Norfolk Street, Strand, London, W.C.
Mather & Platt, Ltd., Salford Iron Works, Manchester.
Newton Bros., Derby.
Thomas Parker Limited, Wolverhampton.
Phœnix Dynamo Mfg. Co., Ltd., Bradford, Yorks.
Rhodes Electrical Manufacturing Co., Ltd., Bradford.
Sandycroft Foundry Co., Ltd., Chester.
Siemens Bros. Dynamo Works, Ltd., York Mansion, York Street, Westminster, London, S.W.
Frank Suter and Co., Ltd., 66, Berners Street, London, W.
Union Electric Co., Ltd., Park St., Southwark, London, S.E.

Economisers (Fuel).
E. Green and Son, Ltd., Wakefield.

Electric Fittings.
McGeoch, William, and Co., Ltd., 28, West Campbell Street, Glasgow.
Frank Suter and Co., Ltd., 66, Berners Street, London, W.

Electrical Equipment (Complete).
A. E. G. Electrical Co. of South Africa, Ltd., 605-6, Caxton House, Westminster, London, S.W.
British Westinghouse Electric and Manufacturing Co., Ltd., Norfolk Street, Strand, London, W.C.
Crompton and Co., Ltd., Salisbury House, London, E.C.
Drake and Gorham, Ltd., 47, Spring Gardens, Manchester.
Electromotors, Ltd., Openshaw, Manchester.
Goodman Manufacturing Co., Ltd., Bank Buildings, St. Mary Street, Cardiff.
J. H. Holmes and Co., Newcastle-on-Tyne.
India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd., 106, Cannon Street, London, E.C.; and Silvertown, E.
Mountain and Gibson, Ltd., Elton Fold Works, Bury.
Siemens Bros. Dynamo Works, Ltd., York Mansion, York Street, Westminster, London, S.W.

Engines (Steam, Oil, and Gas).
Browett, Lindley and Co., Ltd., Patricroft, Manchester.
Campbell Gas Engine Co., Ltd., Halifax.
Cundall, Sons and Co., Ltd., Shipley, Yorks.
Diesel Engine Co., Ltd., 179, Queen Victoria Street, E.C.
Richard Hornsby and Sons, Ltd., Grantham.
James Howden and Co., Scotland Street, Glasgow.
Charles D. Phillips, Newport, Mon.

Engravers.
Press Etching Co., 12, Wine Office Court, Fleet Street, London E.C.

Exhibition Fitters.
A. Elmes and Co., Upper Street, Islington, London, N.

Fans.
Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Electrical Supplies Co., 4, Southampton Row, London, W.C.
Electromotors Ltd., Openshaw, Manchester.
General Electric Co., Ltd., 71, Queen Victoria Street, London, E.C.

Fire Appliances.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Forced Draught.
James Howden and Co., Scotland Street, Glasgow.
Meldrum Bros., Ltd., Timperley, Manchester.

Friction Clutches.
David Bridge and Co., Mars Iron Works, Castleton, Manchester.

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Reason Manufacturing Co., Ltd., Lewes Road, Brighton.

(*Continued on page* 4.)


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Buyers' Guide—*continued from page 2.*

Gearing.
George Angus and Co., Ltd., Newcastle-on-Tyne.
Bufloline Noiseless Gear Co., Ltd., Levenshulme, Manchester.
Hans Renold, Ltd., Progress Works, Manchester.

Generators.—See Dynamos and Motors.

Haulage Gears (Electric).
Corlett Electrical Engineering Co., Ltd., Wilcock Street, Wigan.
Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead-on-Tyne.
John Davis and Son (Derby), Ltd., Derby.
General Electric Co., Ltd., 71, Queen Victoria St., London, E.C.
Goodman Manufacturing Co., Ltd., Bank Buildings, St. Mary Street, Cardiff.
W. Neill and Son, Ltd., Bold Iron Works, St. Helens Junction.
M. B. Wild and Co., Ltd., Argyle Street, Nechells, Birmingham.

India-rubber Goods.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

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Hannan and Buchanan, 75, Robertson Street, Glasgow.

Instruments (Electric).
Evershed and Vignoles, Ltd., Acton Lane Works, Chiswick, London, W.
Ferranti, Ltd , Hollinwood, Lancs.
W. H. Harling, 47, Finsbury Pavement, London, E.C.
Nalder Bros. and Thompson, Ltd., 34, Queen St., London, E.C.
Weston Electrical Instrument Co., Audrey House, Ely Place, Holborn, London, E.C.

Insulating Materials.
Connolly Bros., Ltd., Blackley, Manchester.

Lamps and Lighting.
A. E. G. English Manufacturing Co., Ltd., 4/5, New Compton Street, Charing Cross Road, London, W.C.
Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
General Electric Co., Ltd., 71, Queen Victoria Street, London, E.C.
William McGeoch and Co., Ltd., 28, West Campbell Street, Glasgow.
Frank Suter & Co., Ltd., 66, Berners Street, London, W.

Lifts.
A. Smith and Stevens, Janus Works, Queen's Road, Battersea, London.
Wm. Sprowson and Co., Newton Heath, Manchester.
R. Waygood and Co., Ltd., Falmouth Road, Great Dover Street, London, S.E.

Machine Tools.
Bateman's Machine Tool Co., Ltd., Hunslet, Leeds.
Craven Brothers, Ltd., Osborne Street, Manchester, and at Reddish.
J. H. Holmes and Co., Newcastle-on-Tyne.
John Holroyd & Co., Ltd., Milnrow, Lancs.
Hulse and Co., Ltd., Ordsal Works, Salford, Manchester.
B. & S. Massey, Openshaw, Manchester.
Charles D. Phillips, Newport, Mon.
R. G. Ross and Son, Greenhead Engine Works, Glasgow.
John Stirk and Sons, Ovenden Road, Halifax.

Mechanical Stokers.
Ed. Bennis and Co., Ltd., Little Hulton, Bolton.
Meldrum Bros., Ltd., Timperley, Manchester.

Medical Electric Appliances.
Dowsing Radiant Heat Co., Ltd., 24, Budge Row, London, E.C.

Meters.
Ferranti, Ltd., Hollinwood, Lancs.
The Reason Manufacturing Co., Ltd., Brighton.

Mining Tools.
Hardy Patent Pick Co., Ltd., Sheffield.

Motors.—See Dynamos and Motors.

Motor Starters and Regulators.
Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.

Office Equipment.
Partridge and Cooper, Ltd., Fleet Street, London, E.C.
Stolzenberg Patent File Co., 50-53, Bishopsgate Street Without, London, E.C.

Packing (Engine and Steam).
Lancaster and Tonge, Ltd., Pendleton, Manchester.
F. Reddaway and Co., Ltd., Pendleton, Manchester.
United States Metallic Packing Co., Ltd., Bradford.

Paper-makers' Cotton Drying Felts.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Patent Agents.
Bernhard Dukes, 1, Gt. James St., Bedford Row, London, W.C.

Printers.
London & County Printing Works, Drury Lane, London, W.C.

Printing and Washing Blankets.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Publishers.
The Electrical Publishing Co., Ltd., 4, Southampton Row, London, W.C.

Pumps and Pumping Machinery.
Crompton and Co., Ltd., Salisbury House, London Wall, E.C.
Edwards Air Pump Syndicate, Ltd., 3 and 5, Crown Court Old Broad Street, E.C.
Mirrlees Watson Co., Ltd., Glasgow.
Frank Pearn and Co., Ltd., West Gorton, Manchester.
Ernest Scott and Mountain, Ltd., Newcastle-on-Tyne.

Ropes (Driving).
Thomas Hart, Blackburn.

Rubber-covered Bowls.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Scientific Instruments.
Crompton and Co., Ltd., Salisbury House, London, E.C.
John Davis and Son (Derby), Ltd., All Saints Works, Derby.
J. Halden & Co., 8, Albert Square, Manchester.

Screws.
Automatic Standard Screw Co., Church Street, Halifax.

Ship Lighting (Electric).
Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead.
J. H. Holmes and Co., Newcastle-on-Tyne.

"Sphincter-Grip" Armoured Hose.
F. Reddaway and Co., Ltd., Pendleton, Manchester.

Sprinklers.
Mather and Platt, Ltd., Salford Iron Works, Manchester.

Steam Traps, Separators.
Lancaster and Tonge Ltd., Pendleton, Manchester.

Stokers.
Ed Bennis & Co., Ltd., Little Hulton, Bolton, and 28, Victoria Street, London, S.W.
Meldrum Bros., Ltd., Timperley, Manchester.

Switches, Switchboards, &c.
Clarke, Chapman and Co., Ltd., Gateshead-on-Tyne.
Electric & Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.
Ferranti, Ltd., Hollinwood.
India-Rubber, Gutta-Percha, and Telegraph Works Co., Ltd., 106, Cannon Street, London, E.C.
McGeoch, William, and Co., Ltd., 28, West Campbell Street, Glasgow.
Nalder Bros. and Thompson, Ltd., 34, Queen St., London, E.C.
Switchgear Co., Ltd., Newhall Street, Birmingham.
Thames Iron Works, Shipbuilding and Engineering Co., Ltd., Canning Town, London, E.
Union Electric Co., Ltd., Park St., Southwark, London, S.E.

Textile Machinery and Accessories.
Asa Lees and Co., Ltd., Soho Iron Works, Oldham.
Wm. H. Bowker, Union Iron Works, West Gorton, Manchester.
Brooks and Doxey, Ltd , Union Iron Works, West Gorton, Manchester.
Cook and Co., 18, Exchange Street, Manchester.
Mather and Platt, Ltd., Salford Iron Works, Manchester.
Platt Bros. and Co., Ltd., Hartford Works, Oldham.
Joseph Stubbs, Mill Street Works, Ancoats, Manchester.
Tweedales and Smalley, Ltd., Castleton, near Manchester.

Tramway and Railway Equipment (Electric).
British Westinghouse Electric and Manufacturing Co., Ltd., Norfolk Street, Strand, W.C.
Mountain and Gibson, Ltd., Elton Fold Works, Bury, Lancs.
J. G. White and Co., Ltd., 22A, College Hill, Cannon Street, London, E.C.

Transporters.
Temperley Transporter Co., 72, Bishopsgate Street Within, London, E.C.

Tubes.
Stewarts and Lloyds, Ltd., Oswald Street, Glasgow.

Watches (Non-magnetic, &c.).
S. Smith and Son, 9, Strand, London, W.C.

Winches (Electric) and Speed Reducing Gears.
Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead.
R. G. Ross and Son, Glasgow.

Winding Engines.
Sandycroft Foundry Co., Ltd., Chester.

Index to Advertisers.

For specialities and manufactures of firms below, see preceding Buyers' Guide.

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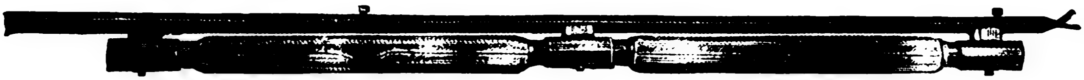

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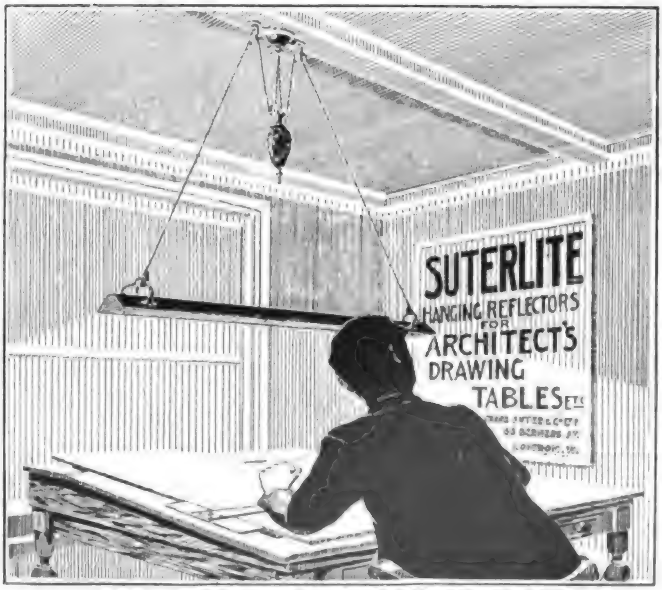

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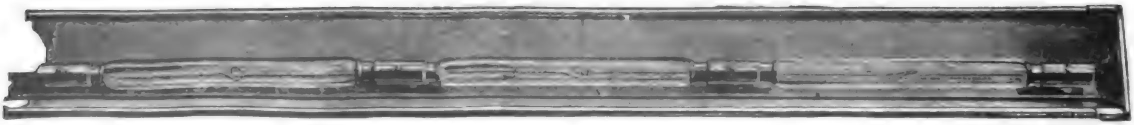


(45th Issue.)

The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. VIII. No. 3. LONDON. SEPTEMBER 28th, 1907.

The World's Electric Progress.

The Engineering and Machinery Exhibition.

ON the 19th inst. Sir Alexander B. W. Kennedy opened the second Engineering and Machinery Exhibition at Olympia. The ceremonials of the opening passed off with the customary eulogies of promoters, supporters, organizers, &c. Sir Alexander is the president of the exhibition, and in the course of a speech outlining the success of last year's exhibition he indicated the chief features of the present and larger show. The present exhibition is certainly more varied and representative in the range of machines and appliances shown, and it is very much larger in extent. A number of leading specialists have arranged to give lectures on a variety of subjects of immediate interest to the engineering and inquiring public.

A very commendable feature is the encouragement extended to students and artizans, who are favoured with reduced prices of admission.

Referring to last year's exhibition, the President mentioned that its success had been the cause of the promoters handing a sum of £500 over to the funds of the engineering benevolent societies, a deserving and quite appropriate, but none the less welcome, gift, he (the president) averring that in these several benevolent societies the money they had to work with was all too insufficient; that for one helped therewith many others had perforce to go without assistance. It is intended that this cause of charity shall again be helped if at all possible, and judging by the patronage and popularity of the exhibition, it would seem that quite a handsome donation will be duly recorded.

The Colonial interest in the Empire's engineering development was exemplified by the presence at the opening function of several Agents-General, including those of New South Wales, Queensland, South Australia, and Natal. The task of proposing "Success to the Exhibition" fell to the Hon. Sir Horace Tozer, the Agent-General for Queensland, who touched upon the advertising and educational value of the exhibition. The most noteworthy point of his speech was, however, the statement that he had, since the beginning of this year, purchased for his Colony British machinery to the value of £500,000.

There are very many decided novelties to be seen, and it is impossible to select any one or other as meriting particular mention here. Elsewhere in this number we publish a short account of many of the principal exhibits; pressure of space and time have prevented our notice of every stand. We

have, however, in hand the preparation of a fully illustrated and detailed account of the most novel and useful of the exhibits. This will form a special feature of the next number (October issue) of THE ELECTRICAL MAGAZINE, which will be considerably enlarged for the purpose, and will be widely circulated in the Colonies. We have a stand in the main hall of the exhibition, where our staff is in constant attendance, and readers can depend upon receiving with our next number a valuable compilation and treatise of very much that is right up to date in the engineering world.

A Submerged Hydro-Electric Power Plant.

A REMARKABLE power installation, of which some details and illustrations appear in the Power Section of this number, has been lately completed on the Patapsco River, Maryland, U.S.A. The dam across the river is of hollow construction, the interior serving as the power house. Reinforced concrete has been used for its construction, the outside main dimensions being: length, 220ft.; width at base, 40ft.; the normal height from tail water to crest, 26½ft. The height of the dam is increased by 10ft. at each end to allow for flood times, and to afford access to the power house in its interior. The walls of the dam are 18in. thick at the base, tapering upwards to 10in. at the crest. The apron extends only half-way down on the downstream side, its lower surface having an upward sweep deflecting the water from the lower face of the dam. Here in the lower vertical face the dam is left open and fitted with windows for the lighting of the power house. On a fine day and with clean water the window lighting is all that could be desired; naturally in wet weather and with the river discoloured the lighting is not so effective.

Only a portion of the dam interior, about 108ft. length, is at present used for powerhouse purposes, and this is lined with a false ceiling to deflect any moisture which may percolate through, although it should be noted that in the unlined part of the dam there is practically no leakage. This unique installation has apparently been carried out with perfect success. It has certainly been the means of considerably reducing the first cost of the power system. The engineers of the scheme report that the size of dam in this instance is probably the smallest that could be utilized for an interior installation, but that where dams are 40ft. high or more no difficulties as to restricted space need be anticipated.

Synchronous Motors on Power Circuits.

AN abstract of an article of the greatest interest and value to the engineer of alternate-current supply work appears in the Power Section of this number. The author goes fully into details as to how, and to what extent, synchronous motors can be used profitably on an alternate-current power network for the correction of power factors. This is a subject which is receiving considerable attention just now, and it is only quite lately that practical use has been made of the counter-action of the leading current of the synchronous motor against the lagging currents of the low-power factor plant. The article in question deals clearly with the general conditions of such service, and works out the data and costs of certain specific cases. The general deductions arrived at are as follow:

In small plants where there is no call for the mechanical power output of a special synchronous motor, it is best to look rather to the correct proportioning of the generating

set for the expected low-power factor than to attempt to correct or raise the latter.

Where synchronous motors are adopted it is best to place them on a paying load; the more mechanical power which can be utilized from the motor, the less, of course, is the amount chargeable to it as a power-factor raiser.

As a rule, it is not economical to attempt to raise power factors to higher values than 90-95 per cent. with this method.

In order to keep down the drop in wiring, the synchronous motor should be installed near the end of the lines. If installed in the power house, it will, of course, reduce the load on the generator, but will not improve the line conditions. It is not very efficient when connected to exciters in the power plant unless it can be made to furnish more mechanical power than that required for exciting. If the exciter generators, however, furnish current for other work than that required for excitation—for example, such as operating direct-current cranes and other variable-speed motors about the plant—then large returns from the synchronous motor-driven exciter outfit may be obtained. The greater the mechanical output the larger the returns.

When induction motors are replaced by synchronous motors in order to improve the power factor the exchanges should be made on the larger sizes so as to reduce to a minimum the number of synchronous motors required.

Rotary converters may be operated at leading current and made to assist in improving power factor. Spare generators, which may be disconnected from their prime movers, may also be used as synchronous motors and floated on the line.

Helion Filaments.

SOME few months ago we published a full description of the new Helion lamp, whose remarkable characteristics lead one to expect that it is destined to play a leading part in future electric lighting development. In a recent issue of the *Electrical Review* of New York is an article by one of the discoverers of the Helion light—Mr. Walter G. Clark. After criticising in a general way the properties of carbon filaments and metallic filaments—with every type of which the author claims to have experimented fully—the article gives details of the work done in the perfecting of the Helion lamp. The following summary of the results arrived at and claims made is of exceptional interest:

The Helion filament is a composite filament in which the base used is a very small carbon filament. It is possible to use other bases, but carbon seems best suited to the requirements. The small carbon base is mounted in a treating jar very similar to the one ordinarily used in treating or flashing the carbon filament. In this treating flask a compound containing silicon is deposited upon the filament. For this purpose has been developed apparatus which is very nearly as automatic as the method used in flashing the carbon filament. The material deposited is, apparently, at first carried into the carbon, but as the process is carried further the filament takes on a surface deposit. As soon as this occurs the emissivity increases very greatly, and the colour of the light changes from the characteristic colour of a carbon filament to a much whiter light, and this with practically no change in temperature.

The filament is built up with this deposit until the desired resistance is reached, when the current is cut off. The filament is then ready to be mounted in the ordinary glassware as used for a carbon filament. The resistance of the Helion filament is sufficiently high to utilize 110 volts in a single corrugated loop, and the filament has sufficient mechanical strength so that it is practically impossible to break it without breaking the glass enclosing the lamp.

The filament may be burned in any position, and in some recent tests a temperature of 3300deg. Centigrade was reached before the filament showed any very decided tendency to sag or soften.

It has been found that the Helion filament possesses a negative temperature coefficient up to about 1350deg. Centigrade, at which temperature the coefficient becomes positive, and from there on the filament exhibits a decidedly positive temperature characteristic;

so in the Helion filament occurs the negative temperature coefficient at starting, and the desirable positive temperature coefficient at the temperature at which the filament is to operate. Another feature possessed by the lamp is that the decrease in candle-power appears to be very slight; experience indicates that the lamp would operate up to a point where the filament parts, with a reduction in efficiency of less than 5 per cent.

The filament, on account of its positive temperature coefficient when incandescent, withstands an overload remarkably well, and an excessive voltage usually destroys the leading-in wires or the glass in the stem of the lamp without damaging the filament.

That the lamp is able to operate at an efficiency of better than 1 watt per candle-power in the larger-sized lamps is indicated by the fact that a lamp of 400c.p. at 300 watts burned for about 300 hours in a very imperfect vacuum, after which the filament was taken down and examined; but apart from the oxidation due to the air present when the lamp was started, there was practically no change in the filament.

There has been considerable difficulty in obtaining a cement which would form a joint beween the filament and the leading-in wire, but a cement has now been produced which appears to fulfil the requirements, and the inventors are now engaged in developing commercial methods of manufacturing the filaments and the materials required in its production.

Our Offer to Students and Apprentices.

THIS is the time of year when many recruits are drafted into the ranks of engineering, when students begin their college careers, and when those apprentices or pupils of a few years' standing resume their evening studies. To all such we have to indicate the special article which appears on page 196 of this number, and the notice at foot of this page. THE ELECTRICAL MAGAZINE has attributes which render it peculiarly suitable for the young engineer, and we have made a point of placing it within his easy reach. That the merits of this journal are appreciated amongst students generally is shown by the large number of student subscribers always on our books. We believe that the low subscription rate now offered and the incentive of the Premium System introduced will encourage students, apprentices, and artizans to promote the popularity of THE ELECTRICAL MAGAZINE amongst their fellows to our mutual advantage.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

A Remarkable Hydro-Electric Plant.

THE generating plant of the Patapsco Electric and Manufacturing Company, of Ellicott City, Md., is unique in that it is placed within the river dam and is thus completely under water. A full description of the installation appeared in a recent number of the *Electrical World*, from which the following facts are taken.

The dam has a total length of 220ft. and is 40ft. wide at the base. The height of the dam from normal tail water to the crest is $26\frac{1}{2}$ft. At each end the buttresses and deck of the dam rise 10ft. above the spillway as a protection from floods and to afford convenient entrances to the interior of the dam. The spillway is 168ft. long and is provided with anchor bolts so that if at any time it may be deemed desirable, flash-boards may be bolted to them and the available head increased 2ft. The dam is built of reinforced concrete and the "deck" is supported by nineteen buttresses 24in. thick at the bottom and 16in. thick at the top, which are placed 12ft. apart. The mixture used was 1 : 3 : 6. The edges of the buttresses and of the openings are reinforced with $\frac{3}{4}$in. corrugated iron rods in groups of three. The shell of the dam is 18in. thick at the bottom and tapers to 10in. at the top. The concrete in the deck is a 1 : 2 : 4 mixture reinforced with $\frac{3}{4}$in. corrugated iron bars at graduated distances down to $4\frac{1}{2}$in. centres. The apron extends only halfway down from the crown, the remaining down-stream portion being entirely open and provided with windows by means of which the interior is lighted. The shape of the apron is such that the water is thrown some little distance away from the windows. On a clear day the illumination is all that could be desired; while during rainy weather, at which time the water is muddy, the illumination is not quite so good. The views of the interior of the power house show how much light is received through the windows beneath the falls.

At present only 108ft. of the dam is used for housing the power plant. This part of the dam is fitted with a false ceiling hung 5ft. from the inside of the dam so as to protect the apparatus from any water that might soak through the outer shell of the dam. The dam is built of a fine and rich mixture which was laid very wet. Aside from this no precautions were taken to eliminate water. The ceiling slopes until it reaches the vertical sides forming the power house. That portion of the dam not protected with the false ceiling is comparatively dry, as very little water percolates through. What little water finds its way through the concrete trickles along the under side to the drain at the bottom. The waste water going over the crest of the dam is carried on the apron of the spillway to within 16ft. of the tail water. This apron causes the water to fall about 20ft. from the down-stream side of the dam, and as the river bed is quite rocky at this point, no appreciable pitting takes place.

A fish ladder is placed at one side of the

dam, as required by law. This is 125ft. long and has the proper slope and fins so that fish can easily go from the tail water to that above the dam.

The power plant equipment consists of two 34in. horizontal Leffel water-wheels fitted with Woodward governors arranged so that either governor may control both wheels when the generators are operated in parallel. Each turbine runs at a speed of 240r.p.m. and is direct-connected to an Allis-Chalmers 300kw., 11,000-volt, three-phase, 60-cycle alternator. Space has been provided for an additional unit of the same capacity.

Each alternator is provided with a 125-volt exciter belted to the shaft. The part of the dam used as a power house is 108ft. long, 10ft. high, and 27ft. wide except at the buttresses, where the width is 18ft. The arrangement of the machinery is well shown in the engravings and in the plan and cross-sectional elevation of the dam. A concrete-steel floor is placed at a proper elevation above the lower pool between buttresses, the latter being increased in section below the floor. The hollow interior structure is built upon this floor as indicated in Fig. 4.

FIG. 2. VIEW SHOWING LIGHTING FROM THE WINDOWS BENEATH THE WATERFALL.

The water is fed to the turbines through steel pipes passing through the up-stream spillway shell and discharged by draft tubes into the base of the dam, dropping into a well sunk some 3ft. below the river bed. The water passes thence by way of a channel constructed in the river bed, out of the dam. The intake is 5½ft. below the crest of the spillway, so that the trash racks are kept clear of driftwood, &c. The trash rack is

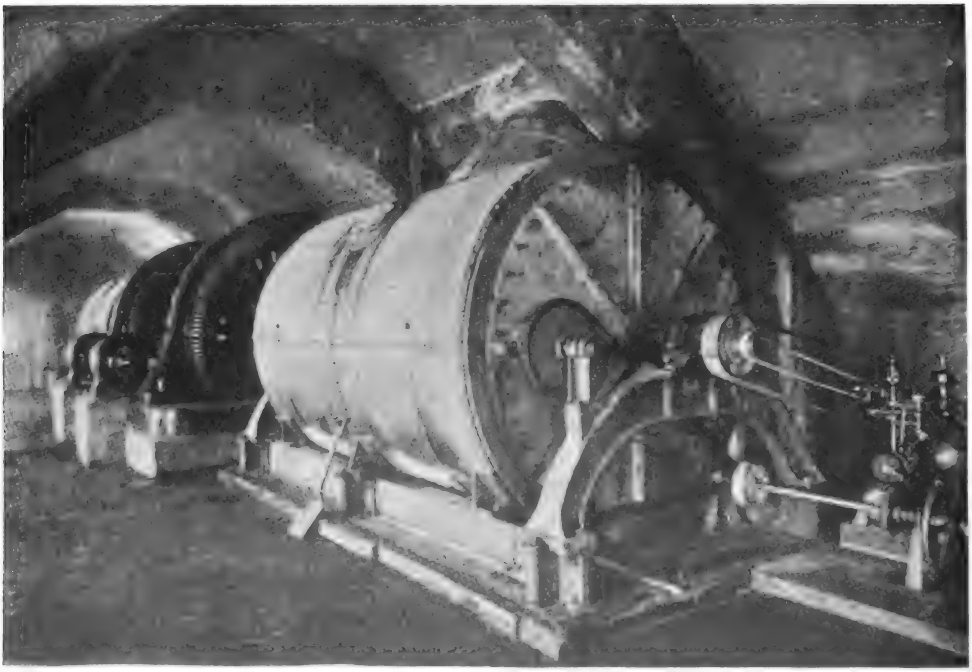


FIG. 1. GENERAL VIEW OF THE DAM INTERIOR SHOWING HYDRO ELECTRIC GENERATING SETS.

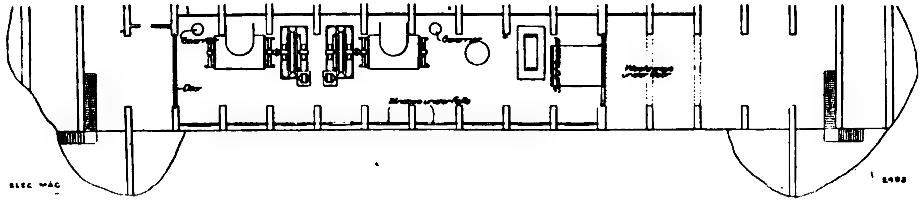


Fig. 3. Plan of Submerged Power House and Dam.

10½ft. and the flumes to the turbines 7ft. in diameter. Two waste gates are placed near the bottom of the dam, the water from these passing under the floor. The flow through the feed pipe is controlled by a valve operated from the turbine chamber.

The mechanism for operating this valve is shown to the right in Fig. 1. The

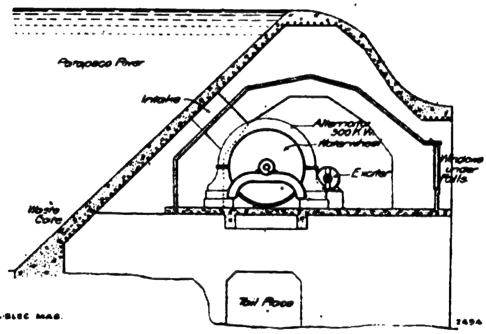


Fig. 4. Section showing Dam Construction and the Power House and Plant in its Interior.

advantages of such an arrangement of water-wheel and generator are readily discerned. The dam foundation and the structure are the power house; the chamber is free from moisture by reason of the free circulation of air around it and the development utilises all the available fall.

The entire electrical installation is compact, secure, and of the highest efficiency so far as it can be obtained from flow and fall. It will be appreciated that the water falls directly through the top of the dam into and through the wheels below, thus avoiding the friction and other losses of power resulting from carrying the water through long race ways to the wheels. The difference between the present system and those already in vogue may be likened to direct-driven and belt-driven machinery. The actual saving in power, or, what amounts to the same thing, the greater efficiency of the water, will be approximately equal to the difference between belt and direct-drive.

Synchronous Motors for Improving Power-Factor.

WILLIAM NESBIT.

The use of synchronous motors for introducing leading currents into circuits of low power-factor for the purpose of improving the power-factor is now being given more attention than formerly. In this article, from *The Electric Journal*, are considered the most efficient points to which the power-factor should be raised; the advantage of making the synchronous motors give out mechanical power (in addition to improving the power-factor); and the advantage derived by installing a synchronous motor in a specific case.

The power-factor of induction motor-driven plants usually varies between 55 per cent. and 85 per cent. A power-factor of 55 per cent. is unusual, and would indicate that some of the motors were under-loaded. Such a condition would, of course, be improved by replacing such motors with motors of smaller capacity. The power-factor of alternating-current arc lamps is approximately 70 per cent., that of induction motors in capacities between 1h.p. and 100h.p. is, for full-load, 80 per cent. to 90 per cent., and for half-load, 60 per cent. to 80 per cent. Many plants are to-day operating at a combined power-factor of 70 per cent.

As an illustration the effect of a synchronous motor on a circuit delivering 1000k.v.a. at 70 per cent. power-factor (700kw. true energy) will be considered. The 1000k.v.a. will be considered the full-load k.v.a. rating of the steam-driven direct-connected generators and it will be assumed that there is a demand for more power to the extent of 200h.p. or 300h.p. This may be obtained either by raising the power-factor of the present generator load, or by installing a new generator and engine. If the generators in this plant were rated at

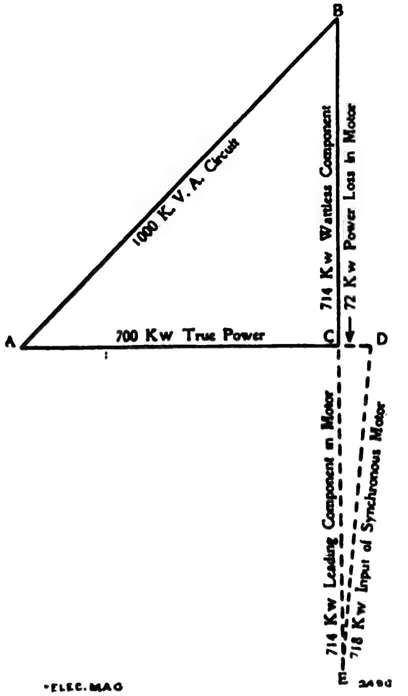


Fig. 1.

100 per cent. power-factor, as was often the case in the past, and is to a surprising extent to-day, then the plant is very badly out of balance for 70 per cent. power-factor operation. In this case the engines, boilers, piping, wiring, and in fact all the equipment with the exception of the generators, have sufficient capacity to drive the generators at 100 per cent. power-factor rating (1000kw. true energy). On account of the generators being rated at 1000kw. 100 per cent. power-factor, they can deliver only 700kw. true power at 70 per cent. power-factor. Therefore, the available capacity of this plant has been reduced from 1000kw. to 700kw. or 30 per cent., on account of generators being installed having a 100 per cent. power-actor rating in place of a 70 per cent. power-factor rating. If it was not the intention to install any synchronous motors in this plant, but simply allow the power-factor to take care of itself, then larger generators should have been installed on these engines or smaller engines on the present generators. If generators having a combined rating of 1430k.v.a. in place of 1000k.v.a. rating had been installed, then this plant would deliver 1000kw. true power (1430k.v.a. at 70 per cent. power-factor.)

Power-factor raised to Unity.—Fig. 1 shows graphically the conditions existing in this plant. Here *AB* represents the 1000k.v.a. load, *AC* the true power (700kw.), and *BC* the wattless component (714kw.). The angle *BAC* is the angle of lag, *AC* representing the direction of voltage and *AB* the direction of the current. Since there is $\sqrt{1000^2-700^2}=714$kw. wattless component in the circuit lagging 90deg. behind the voltage, in order to raise the power-factor to 100 per cent. it would be necessary to introduce the same amount of leading wattless power into the same circuit. This is shown in Fig. 1 by the line *CE*, 180deg. from *BC*. Assuming the true watt loss in the motor as approximately 10 per cent. of its full load rating and drawing the line loss *CD* (72kw. in phase with the true power of the circuit), the synchronous motor triangle *CED* is formed, in which *ED* (718k.v.a.) is the input of the synchronous motor, *EC* (714kw.) its leading wattless component, and *CD* (72kw.) its true power component. A synchronous motor, therefore, having a capacity of 718k.v.a., floating on this circuit without doing any mechanical work, would raise the power-factor of this circuit to unity and reduce the load on this plant from 1000k.v.a. to 772kw. (700 + 72) or a reduction of 228kw. This gain in capacity has been obtained at the expense of the first cost of the 718k.v.a. synchronous motor and the cost of furnishing the power lost in the motor.

From the above it will be seen that in case the synchronous motor is not made to

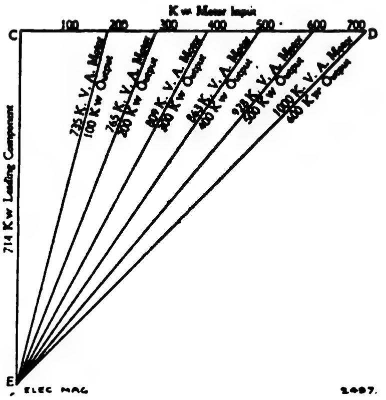


Fig. 2

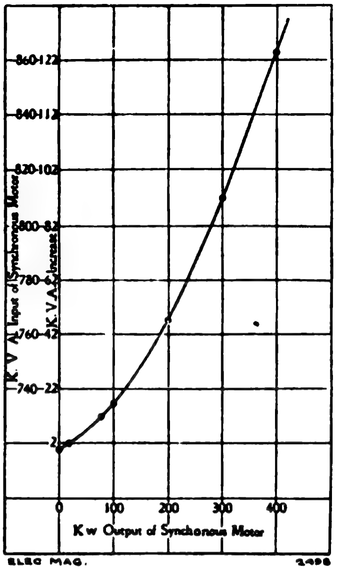


FIG. 3.

give out any mechanical power, the capacity of the synchronous motor for obtaining unity power-factor is quite large compared with the gain in plant capacity. In this case a 718k.v.a. synchronous motor reduces the generator load only 228k.v.a.

Fig. 2 shows graphically the conditions when the synchronous motor in addition to raising the power-factor to unity is made to furnish varying amounts of mechanical power. Here *EC* (714kw.) represents the lagging component in the circuit and the leading component in the synchronous motor. *CD* represents the true kw. input of the synch·onous motors. The six diagonal lines represent the capacity required for the motor that will, in addition to raising the power-factor to unity, deliver 100kw., 200kw., 300kw., 400kw., 500kw., and 600kw. respectively in the form of mechanical power. At the points where the diagonal lines intersect the line *CD*, the input of the synchronous motor may be read off (assuming 10 per cent. loss in the motor). Thus a 1000k.v.a. motor will deliver 600kw. mechanical power with an input of 600 + 100 or 700kw.

The large return in the form of mechanical power delivered by the synchronous motor for slight increases in capacity is shown in the form of a curve in Fig. 3. By consulting this curve it may be seen that by increasing the capacity of this synchronous motor from 718 to 720k.v.a., or by 2k.v.a., it will deliver 21kw. mechanical power in addition to raising the power-factor of the circuit to unity. By increasing its capacity to 830k.v.a., or by 12k.v.a, it will deliver 79kw. mechanical power. By increasing its capacity to 1000k.v.a. it will deliver 600kw. mechanical power.

Looking at it another way, 2k.v.a. increase in capacity of synchronous motor gives a return in the form of mechanical power of 1050 per cent., 12k.v.a. increase gives 658 per cent., and 282k.v.a. increase gives 212 per cent. The per cent. (based on the rating of the 718k.v.a. motor) available in mechanical power corresponding to various per cent. increases in the capacity of the motor is shown in the form of a curve in Fig. 4. Thus 5 per cent. increase in capacity of the synchronous motor enables it to deliver 23.5 per cent. of its 718k.v.a. rating in the form of mechanical power; 10 per cent. increase, 36 per cent.; and 25 per cent. increase, 63.5 per cent.

The importance of making the synchronous motor give out mechanical power is therefore self-evident, and the more mechanical power which can be utilized from it, the less will be the amount chargeable to it for raising the power-factor.

Power-factor raised to less than unity.—As it is seldom economical or necessary to raise the power-factor of a circuit to unity, the raising of the power-factor of this circuit to 90 per cent. in place of 100 per cent. will be considered. Fig. 5 shows graphically the new conditions, the motor in this case not

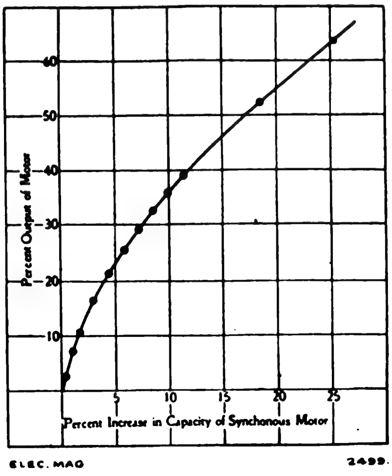


FIG. 4.

delivering any mechanical power. Here,—

AB = 1000k.v.a. load at 70 per cent. power-factor.

AE = 700kw. power component.

BE = 714kw. lagging wattless component.

$CD = EF$ = Power input of synchronous motor.

$EG = BC$ = Leading component of synchronous motor.

BD = FG = Capacity of synchronous motor required.

AF = True energy in circuit, including motor input.

DF = Lagging wattless component in circuit of 90 per cent. power-factor.

AD = k.v.a. load in circuit of 90 per cent. power-factor.

In order to determine the value of FG it may be noted that:

$$AE = 0.7AB$$

$$AF = 0.9AD \quad \text{or} \quad AD = \frac{AF}{0.9}$$

$$BE = 0.714AB$$

$CD = 0.1BC$ (assuming approximately 10 per cent. motor loss).

Now, $AF = AE + CD$

$$AD^2 = AF^2 + DF^2 \text{ or } DF^2 = AD^2 - AF^2$$

$$BC = BE - DF$$

$$BC = 0.714AB - \sqrt{AD^2 - AF^2} =$$

$$0.714AB - \sqrt{\frac{AF^2}{0.81} - AF^2} = 0.714AB -$$

$$\frac{AF}{0.9}\sqrt{0.19} = 0.714AB - \frac{0.7\,AB + 0.1\,BC}{0.9}$$

$$\sqrt{0.19} = 0.714AB - 0.339AB - 0.0484BC$$

or, $1.0484BC = 0.375AB$.

BC = 358kw. leading current in motor.

CD = 36kw. input of motor.

FG = 360k.v.a. capacity of motor.

The capacity of the synchronous motor required to raise the power-factor of a circuit to any value may be obtained by the above method, assigning the proper values to the various equations for the power-factor required and the power-factor of the circuit before the synchronous motor is added. The capacity of the motor required may be very closely approximated by laying it out graphically on a fairly large scale.

Below is given the capacity of motors required to raise the power-factor to various amounts:

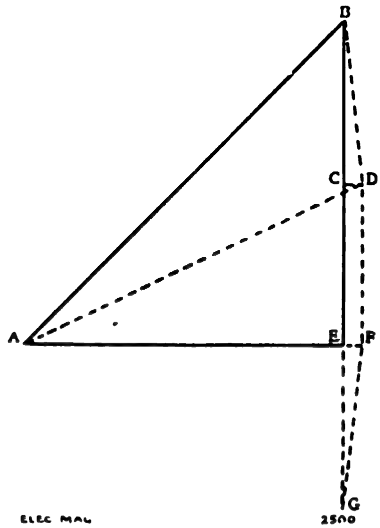


Fig. 5.

Power-Factor per cent.	Synchronous Motor k.v.a.	Generator.		Relative Gain k.v.a.
		Load k.v.a.	Increase in Capacity.	
75	107	935	65	0.61
80	177	897	103	0.58
85	264	855	145	0.55
90	360	818	182	0.51
95	470	787	213	0.45
100	718	771	229	0.32

In the above table the second column contains the k.v.a. capacity of the synchronous motor required to raise the power-factor of this circuit (including motor loss) to the values given in the first column. The third column gives the k.v.a. load with the motor in use. The fourth column gives the reduction in generator load. The last column gives the k.v.a. generator capacity gained per k.v.a. capacity of synchronous motor for the power-factors given.

Fig. 6 shows the above in the form of a curve. At 75 per cent. power-factor for each k.v.a. capacity in synchronous motor, 0.61k.v.a. additional generator capacity, and for 100 per cent. power-factor for each k.v.a. in capacity in synchronous motor, 0.32k.v.a. additional capacity in generators is made available. In other words—the return in additional generator capacity is, at 75 per cent. power-factor, about double what it is at 100 per cent. power-factor. This would

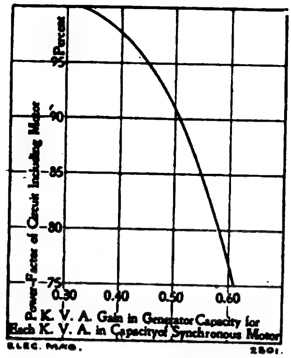


FIG. 6.

indicate that an increase of say 5 per cent. in the power-factor can be obtained more cheaply when the power-factor is low than when it is high, and that it would probably not pay to attempt to increase the power-factor above about 95 per cent.

Advantage of a Synchronous Motor in a Specific Case.—Since it is desirable to make the synchronous motor do mechanical work in addition to improving the power-factor, and since the greatest returns may be looked for when the power-factor is raised to a point in the neighbourhood of 95 per cent., a consideration will be given of the cost of installing a synchronous motor in the case which has been considered and the advantage derived. Assuming that the plant is delivering its normal capacity of 1000k.v.a. at 70 per cent. power-factor, and that two or three hundred horse-power is required to drive additional motors, the power-factor of this circuit including the motor may be raised to 95 per cent. while delivering 1000k.v.a. This is shown graphically in Fig. 7.

Here—

AD = 1000k.v.a. in the generator load at 95 per cent. power-factor.

AF = 950kw. is the true generator output at this power-factor.

DF = 312kw. is the wattless component in the circuit.

$EG = BE - CE$ = 402kw. leading component in motor.

$EF = AF - AE$ = 250kw. true input of motor.

$GF = \sqrt{402^2 + 250^2}$ = 475k.v.a. capacity of synchronous motor required. The loss in the motor at 10 per cent. would be 47kw., and is represented by the line EH.

A 475k.v.a. motor will therefore raise the power-factor of this 1000k.v.a. circuit to 95 per cent., and will, in addition, furnish 250 − 47 or 203kw. of mechanical power. If, for example, synchronous motors of this capacity cost $10 per k.v.a. delivered and erected, then since the 475k.v.a. synchronous motor delivered 203kw. in mechanical power, it is fair to charge only 475 − 203 or 272k.v.a. to power-factor improvement, therefore $2720 would be required to increase the capacity of this plant by 203kw. by raising the power-factor.

If the capacity is increased by installing a new generator, engine, necessary piping, &c., the cost would be approximately $10,000 for a 203k.v.a. generator outfit. In other words, a new generator outfit to increase the output of this plant 203kw. would cost $10,000 − $2720, or $7280 more than a 475k.v.a. synchronous motor delivering 272kw. mechanical power.

Of course, the larger the mechanical output of the synchronous motor the less amount is chargeable to improving the power-factor, and the greater the saving of the synchronous motor outfit. The mechanical power obtained from the synchronous motor is taken in the form of current from the generator at a high power-factor, whereas if additional generator and induction motors are installed in place of a synchronous motor, additional lagging current is introduced into the circuit with its corresponding tendency to lower the power-factor.

Summary.—In some cases where the plants are small and there is no use for a

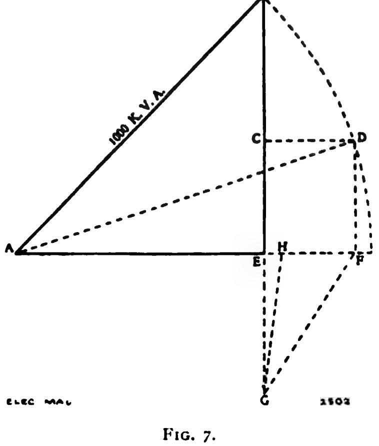


FIG. 7.

large synchronous motor, it is advisable to install generators having a k.v.a. rating at the power-factor likely to be obtained. The erroneous practice, however, is to install generators rated at 100 per cent. power-factor, and thus greatly cut down the available capacity of the plant. This is possibly largely due to the fact that many purchasers do not understand or appreciate the question of power-factor, and when a generator salesman bids on a generator rated on a 70 or 80 per cent. power-factor basis he finds it difficult to convince the purchaser that his generator is worth more than his competitors' who are advocating a generator with a 100 per cent. power-factor rating in order to get the selling price down.

The more mechanical power that synchronous motors give out in addition to furnishing leading current, the more efficient will be the installation.

It rarely pays to attempt to raise the power-factor by the use of synchronous motors to values higher than 90 per cent. to 95 per cent.

Test of Motor Driving a Paint Grinder.

A TEST to determine exactly the power consumed was recently made on a paint mill used for grinding yellow ochre after it has passed through a mixer. The machine consists of two pairs of millstones about 30in. in diameter mounted with axes vertical, the lower stones of each pair revolving while the upper stones are fixed. The latter are fastened to the frame of the mill while the lower revolving stones are carried on the ends of vertical shafts connected by spur gearing and driven from the main shaft by a bevel gear and pinion. The main shaft runs at about 135r.p.m., and with the present belted outfit is provided with tight and loose belt pulleys. The mill is driven from a small countershaft located directly above the main shaft, the motor being suspended from the ceiling.

Paint mixed with linseed oil is fed from a mixer into the upper pair of stones, and after passing through them is discharged to the lower pair. The process is continuous, but when the mill is first started it requires considerably more power than after an hour or so of running, when the stones have become heated and the paint flows more easily. The power also depends on the rate of feed and the setting of the stones, for if the latter are too tightly adjusted the power required is very much increased.

The grinder is provided with a 10h.p, 220 volts, 26amp., three-phase, 60 cycles, belted motor running at approximately 113cr.p m. at full load.

The following tests were made:

1. Motor running idle (belt off).

   Volts, 224-228; current, 6.5-7amp. Total watts, 600.

2. Motor running belting and countershaft (Hill belt and loose pulley).

   Volts, 223-225; current, 7amp. Total watts, 900.

   This shows that power required for belting and countershaft, 300 watts, or 0.4h.p.

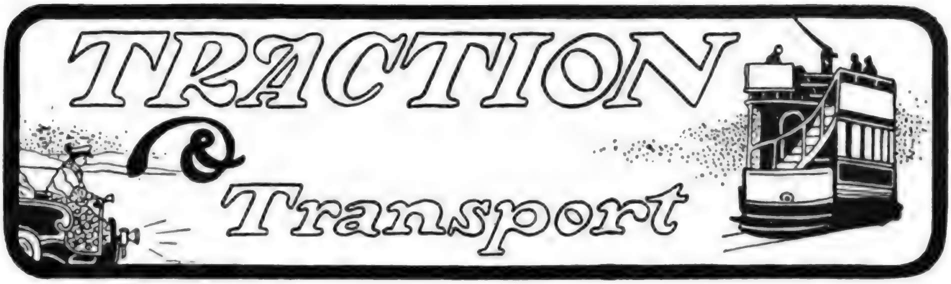
3. Motor running mill and grinding paint under usual conditions.

   Speed of main shaft on mill, 136r.p.m.
   Volts throughout test, 220-226.
   Total watts at beginning of run (mill cold and paint stiff) = 10,300.

   Total watts at end of four-hour run = 7200.

This indicates the decreasing power consumption as the mill becomes warmed up. Total number of kw.-hours during four hour run, as shown by recording meter, was 26. This gives an average of 6½kw. input required to operate the mill.

It was found that 86.75lb. of paint was ground with an expenditure of 24kw.-hours. With millstones in first-class condition it is thought this output could be considerably increased without materially affecting the power consumption. In the present test the stones had not been dressed for some time and the amount of paint ground was therefore lower than it would otherwise have been. The ratio of the wattmeter readings on the two sides of the circuit showed that the motor operated at an average power factor of approximately 90 per cent.



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

Overhead Line Construction on the New York, New Haven & Hartford Railroad.

THE electric trains of the New York, New Haven and Hartford Railroad leave the direct-current zone of the New York Central at Woodlawn, N.Y., and pass on to the alternating-current line which at present extends as far as Stamford, Conn. Upon this section 11,000 volts are employed. The following details of the overhead work are abstracted from the *Electrical World.* The supporting bridges are of varying lengths, so as to accommodate four, five, six, or as many as twelve tracks, as the local conditions require, and are of two types—anchor bridges which are used only at intervals of about two miles, and intermediate bridges. The latter have side posts of square cross-section, and are of comparatively light construction. On the other hand, the anchor bridges have A-shaped posts and are made heavier to withstand the strain of the cables.

The anchor bridges are provided with automatic circuit-breakers, by means of which the different sections may be isolated, and also the several parallel tracks may be electrically separated from one another in case of accident to any one track. The anchor bridges also carry lightning-arresters, shunt transformers for operating the circuit breakers, together with foot walks, hand railings, lamp circuits, and the wires and conduit for the auxiliary control circuits.

The working conductors have sufficient area for the working current, but two auxiliary feeders extend along the entire length of the line. These feeders are connected with the main conductors at each anchor bridge through circuit-breakers and provide means for feeding around any one section in case it is cut out of service on account of some accident in that particular section.

Provision is also made on all of the bridges for carrying two separate feeder wires called "power feeders," which are connected to the third phase of the generating system and are used for operating three-phase apparatus at certain intervals along the road. Provision is also made on the bridges for carrying two three-phase circuits, one circuit being supported on the top of each post at the ends of the bridges.

In laying out the bridges for the section from Woodlawn to Stamford, it was found that the sharpest curvature was 3deg. As this curvature will permit of stringing the trolley wire in straight lines between points of support 150ft. apart without deviating from the centre of the track more than 8½in. on each side, it was decided to place all bridges a fixed distance of 300ft. apart, and on curves to provide guy poles to which pull-over wires are attached and secured to the catenary spans (see Fig. 1). By this means a minimum amount of overhead wiring was obtained, and the deviation from the centre of the track was maintained within safe limits for use in connection with the sliding pantograph trolleys on the locomotives, the bow of which is 4ft long.

The general appearance of the standard

FIG. 1. INTERMEDIATE BRIDGE; GUY POLE AND PULL-OVER WIRES ALSO SHOWN.

four-track intermediate bridge is shown in Fig. 1. This illustration shows also signals mounted on the bridge, the semaphore blades being placed below the truss so as to afford an unobstructed view. As will be noted, the bridge consists of two supporting side posts and a horizontal truss. Each supporting post is approximately 38ft. long × 1ft. 10in. square, and is composed of four 4in. × 4in. × $\frac{7}{16}$in. angles secured together by $2\frac{1}{4}$in. × $\frac{3}{8}$in. lacing bars. Each post rests upon a concrete foundation, containing about 9 cubic yards of concrete. Anchor bolts extend entirely through the concrete foundation and hold the base of the post to the foundation by means of heavy nuts. The cross-truss is attached by means of bolts to the vertical posts, allowing a distance of 23ft. 4in. from the lower side of the truss to the top of the rails. The truss is 4ft. 6in. deep from back to back of the upper and lower chord angles, which latter are placed 1ft. 10in. from back to back. The lacing bars of the upper chord are depressed below the upper surface of the chord angles so that the latter are left free from rivets or other obstructions, thereby affording a ready means for attaching the insulators at any point. The lacing bars of the upper chord consist of flat strap, while the diagonals in the sides and bottom of the truss consist of angles. The upper chord angles are $3\frac{1}{2}$in. × 6in. × $\frac{3}{8}$in., and the lower are 4in. × $3\frac{1}{2}$in. × $\frac{5}{16}$in.

The extensions of the side posts above the trusses are utilised for supporting the feeder wires which are carried upon the angle-iron cross-arms bolted to the posts. The lower cross-arm carries two insulators, upon the inner one of which is carried the auxiliary feeder. The upper cross-arm is placed 5ft. above the lower one and carries two wires of the three-phase circuit. The third wire of the three-phase circuit is carried upon a light vertical channel-iron support.

In the calculation of these bridges very heavy weather conditions were assumed, and provision was made for clamping the catenary cables on the intermediate bridges so that they are obliged to partially withstand the longitudinal pull of the latter. It was assumed that the entire system of the bridges and cables might become coated with sleet, and that this coating might be $\frac{1}{2}$in. in thickness around all surfaces. It was assumed also that the wind pressure on the bridges and the catenary spans might at the same time be as high as 25lb. per square foot. It was further assumed that the effective area of all round cables would be two-thirds of their projected areas.

Each catenary cable is clamped to its supporting insulator on every intermediate bridge, and it was assumed that if one pair of cables should be broken, the remaining cables would exert a balancing influence on the bridge. The truss, however, was made strong enough to prevent its buckling under the strain produced by the breakage of any pair of cables.

Anchor bridges of especially heavy construction are placed every two miles, and against these bridges the catenary cables are anchored. The four-track anchor bridge consists of two A-shaped posts, each having a spread at the base of 15ft., and a width at

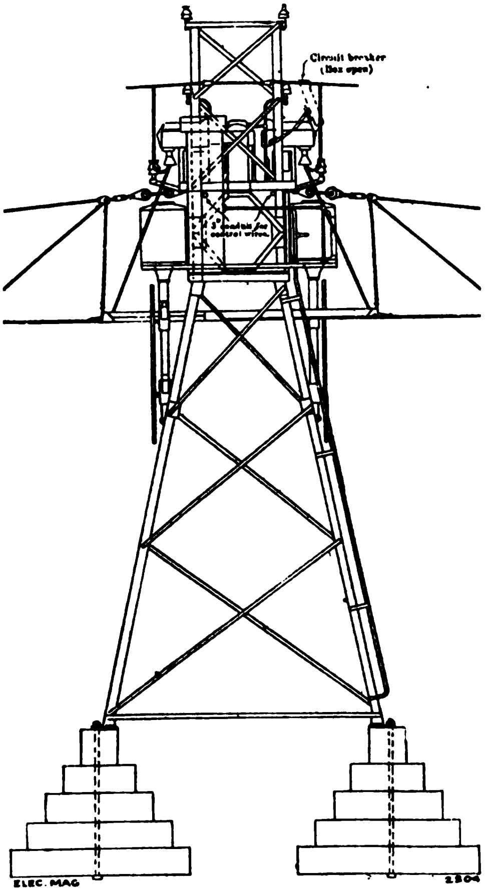


FIG. 2. END ELEVATION OF ANCHOR BRIDGE.

right-angles to the track of about 2ft. The main members of these posts consist of 6in. × 4in. × $\frac{5}{8}$in. angles. These posts are also extended above the truss in the manner shown in the illustration for the purpose of carrying the feeder wires. The truss is bolted to the side posts, allowing a clearance above the rails to the lower side of the truss of 24ft. 3in. The truss is 4ft. 6in. deep by 5ft. wide between the backs of the chord angles. The upper chords consist of 8in. × 8in × $\frac{9}{16}$in. angles, and the lower chords consist of 4in. × $3\frac{1}{2}$in. × $\frac{9}{16}$in. angles.

Fig. 2 represents the side view of the anchor bridge, and Fig. 3 a plan view of the same bridge, from which additional details of the construction may be noted. A ladder is provided on one of the posts leading to a small platform at the end of the truss. This platform is provided with a handrail and carries upon it a box containing an 11,000-volt low-equivalent lightning arrester. A portal is provided in the end of the truss, by means of which the attendant may step on to the platform supported upon the lower chord of the truss. From this platform access is provided to the short ladders leading to the signal lanterns, and a second short ladder extends up to another platform supported upon the upper chord of the truss. This platform is surrounded by a handrail, which is also attached to the iron supporting frames of the circuit-breakers in such a manner that the attendant can in no way come in contact with live parts of the circuits. At each end of the truss a 5kw. 11,000-volt shunt transformer is provided, one of them being connected directly into a bus-bar which runs around the outside of the circuit-breakers and which is supported upon porcelain insulators and bus-bar brackets, secured to the upper chords of the truss. The other transformer is connected directly into one of the "power" feeders. As the "power" feeder is connected to the third phase of the generating system, means are available for operating the switches in case of accident to the trolley section. The four-track anchor bridge is secured to concrete foundation by means of long anchor bolts and nuts. Each post rests upon blocks of concrete, each block containing about 12 cubic yards of concrete.

Each of the two catenary cables which support the copper trolley conductor consists of an extra high-strength steel cable, $\frac{9}{16}$in. in diameter, consisting of seven strands. This steel has an ultimate strength of about 200,000lb. per square inch, and each strand is heavily galvanized. The completed cable has a total strength of 33,800lb. These cables are strung between the bridges with a sag at mean temperature of 6ft. in a standard span of 300ft. Owing to obstructions at certain places along the right of way, the spacing of the bridges is occasionally varied from the standard distance of 300ft. In order to allow for this the cable is run out in long lengths and is pulled up to a uniform tension until the sag in the span of 300ft. is 6ft. The sag in the other spans is allowed to adjust itself, since the tension is the same. After being pulled up to the proper tension the catenary cables are anchored to the anchor bridges and are clamped to the insulators of the intermediate bridges.

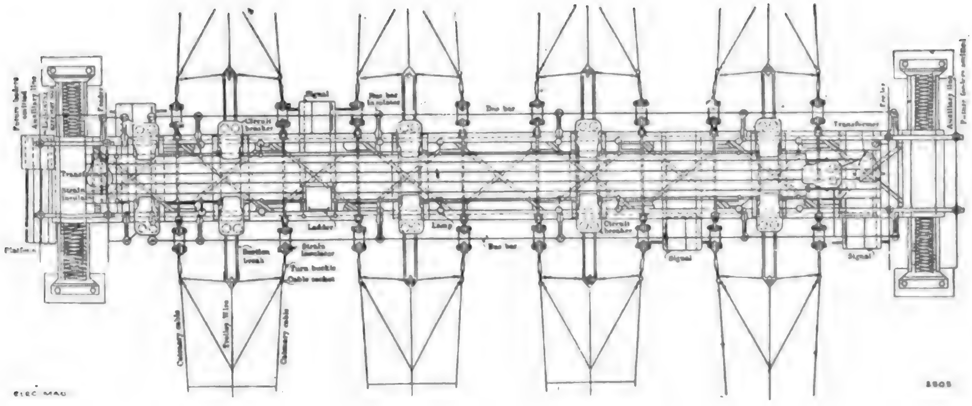


Fig. 3. Plan of Four-Track Anchor Bridge.

The insulators which support the catenary cables of the intermediate bridges consist of heavy porcelain insulators of the skirt type, which are 15in. in diameter and about 7in. high. These insulators are cemented upon short lengths of double, extra strong pipe, which in turn are held by means of U-bolts to a cast-iron yoke, bolted to the upper chords of the truss. The catenary cable rests in a groove in the top of the porcelain and is held by means of a malleable-iron clamp fitted with U-bolts and placed one on each side of the insulator. The head of the insulator is conical in shape and is surrounded by means of a split malleable-iron clamp and a lead packing. One feature of the construction to be noted is the arrangement of the clamp and the collar, which is such that in case of the breakage of the messenger cable on one side of the insulator, the pull of the cable on the other side will cause the clamp to swing downwards, thereby lowering the point of application of the pull of the cable. Thus the porcelain is put in compression, and there is no tendency to shear off the top of the porcelain, as is usually the case with porcelain line insulators. Each porcelain is subjected in the shop to a test of 55,000 volts when assembled.

Fig. 4 represents the general appearance of the strain insulators which are used for dead-ending the catenary cables at the anchor bridges. These insulators, which are of special construction, are designed to withstand a shop test of 50,000 volts and a working load of 20,000lb. Each consists of a length of 2in. extra heavy iron pipe, surrounded at its middle point by an iron collar. Outside of this collar a long insulating tube, composed of especially hard and reliable insulating material, is pressed. This tube is surrounded by a second collar into which a bolt is screwed and to which the turnbuckle of the catenary cable is attached. The entire surface of the insulating tube and the inner and outside collars are then effectively sealed against moisture by means of a high-grade insulating compound applied by means of hydraulic pressure. The insulator thus made up is supported by means of an iron yoke from cast-iron hooks bolted to the upper chords of the anchor-bridge truss.

One of these insulators is provided in each catenary cable at each anchor bridge,

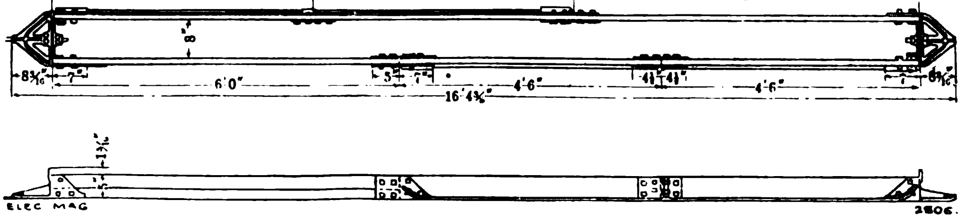


Fig. 4. Details of Strain Insulator.

thereby electrically dividing the road up into separate sections between the anchor bridges.

Midway between the supporting bridges and curves a guy pole is located on the outside of the curve. These guy poles are of two types, namely, rigid and anchored, the former being used wherever there is room on the right of way for the anchorage, while the latter is used in places where the width of the right of way is restricted. A pole of the latter type is seen in place in Fig. 1. Heavy strain insulators are attached to the guy poles at the proper height, and pull-over wires are attached to this strain insulator and to the catenary cable and trolley wires of the several tracks.

The strain insulator is somewhat similar in appearance to the well-known "giant strain," except that it is designed to withstand a test of 50,000 volts, and a mechanical pull of 15,000lb. It is made up of steel castings and solid mica insulating cones, and is sealed with a high-grade insulating compound. These strain insulators are attached by means of one loop in the guy poles, and the pull-over wires are attached to the other loop.

In order to enable any one track to be electrically disconnected from any other parallel track when the circuit-breakers on the anchor bridges are open, insulating separators are provided in the pull-over wires between the tracks (see Fig. 1). Each separator consists of a 5ft. rod of selected hickory, thoroughly impregnated and fitted at the ends with malleable-iron heads secured to the conical-shaped heads of the rods by means of bolts. Each insulator has an ultimate strength of about 16,000lb. At no point in the entire construction is wood relied upon for insulation to ground, and it will be noted that these wooden separators normally have no difference of potential upon them. They are merely provided in case of accident, when it is necessary to isolate one section of track from another. They are, however, subjected to a test of 30,000 volts.

The trolley wire is supported from the catenary cables at 10ft. intervals by means of triangular trolley hangers of varying lengths. These hangers are so adjusted in length that the trolley wire is maintained in a horizontal position, it being 6in. below the catenary cables at the middle point of the span. The hanger consists of a pair of small drop-forged steel jaws, which engage with the grooves of the trolley wire and are clamped by means of a malleable-iron Y, which is screwed down upon the threaded portions of the jaws. The sides of the triangle are then screwed into the Y and are bolted to the messenger cable above. As all of the threads are right-handed, it is impossible for the hanger to come loose.

At each anchor bridge it is necessary to provide an insulator in each trolley wire, and this is accomplished by means of trolley section break insulators. Each consists of two bronze end castings, to which the ends of the trolley wire are bolted. Two parallel sections of impregnated hardwood are fastened to these castings, and to these wooden strips are fastened renewable pieces of trolley wire in such a manner that the ends of these renewable pieces overlap one another in distance along the track, although the two wires are electrically distinct. By this means it is possible for the sliding contact on the locomotive to pass from one section to the next without opening the circuit, thus avoiding all flashing. It will be noted, however, that an effective insulation is provided so that when the circuit-breaker on the anchor bridge is open, the two sections will be disconnected. The manner in which this section insulator is installed is clearly shown in the end view of the anchor bridge, Fig. 2. Insulators in place under an anchor bridge are shown in Fig. 2.

At a number of points along the road overhead bridges reduce the clearance above the tracks. The construction consists of a corrugated porcelain spool, mounted upon an iron pipe, which in turn is supported at each end from a skirt-type porcelain insulator, of the same design as that used on the intermediate bridges. The messenger cables where they pass under the bridge are heavily insulated and the hangers which support the trolley wire from the messenger cable are placed midway between the porcelain insulators so that the maximum amount of flexibility is obtained. The trolley wire hangers are constructed of impregnated wood, so that the trolley is completely insulated from the catenary cables. A waterproof shield is attached to the bridge above the insulating structure so as to prevent accumulations of dirt and water on the insulators.

The type of circuit-breaker which has

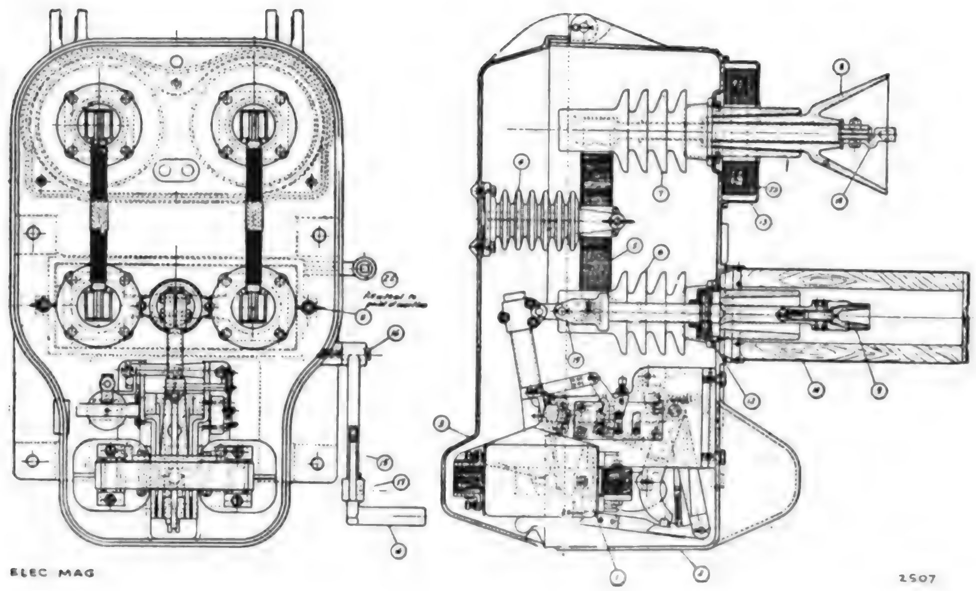


FIG. 5. DETAILS OF CIRCUIT BREAKER.

been developed for this installation is shown in Fig. 5, which gives the details of the device, while Figs. 2 and 3 show the breakers in place on the anchor bridges.

The breaker consists of a cast-iron framework adapted to be bolted to channel irons resting upon the upper chords of the anchor bridges. This framework carries an iron box provided with a hinged cover. The cover is arranged to fit tightly in place so as to exclude all rain and snow and be entirely weatherproof. The moving parts of the circuit breaker are contained within this box and are made especially rugged and reliable in their operation. The terminals of the switch are brought out through specially-constructed insulators mounted in an overhung portion of the box at the rear (Fig. 5). Upon the tops of insulators are carried knife-switch jaws, and there are corresponding jaws mounted on the upper ends of the circuit breaker contacts. Two switch blades are carried on insulating pillars fastened to the hinged cover of the box in such a manner that when the cover of the box is closed one terminal of the switch is connected to the bus-bar on the anchor bridge and the other is connected to the trolley wire. Arrangements are provided so that if the cover is opened the circuit breaker will be automatically tripped so as to prevent any possibility of the attendant taking hold of live parts.

The circuit breaker is capable of handling 11,000 volts on heavy, short circuit. A tripping coil is provided, together with closing magnets, both of which are operated from a circuit supplied from the small shunt transformers on the anchor bridge. The switch is also arranged to open automatically on overload.

The control wires for the closing magnets and the tripping coils are carried in iron conduit and lead-covered cable to the adjoining signal tower, where a switchboard panel is provided. This panel is fitted with switches so that any circuit breaker may be tripped by hand, or closed by the attendant in the signal tower. There is also a switch by means of which the attendant may connect either of the shunt transformers on the anchor bridge to the control circuit.

The auxiliary feeders, which are supported on the inner insulators of the lower bracket arm on the bridges, are looped in to the bus-bars on each alternate anchor bridge. These connections are made through automatic circuit breakers, so that in case of the grounding of the bus-bar structure to any anchor bridge, one of the auxiliary feeders will pass around the grounded bridge to the next section beyond. On each anchor bridge one auxiliary feeder is broken by a strain insulator, and connections are made through circuit breakers to the bus-bar.

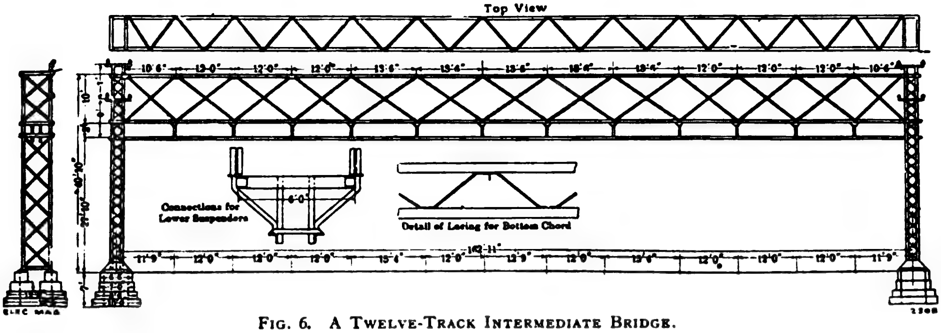


Fig. 6. A Twelve-Track Intermediate Bridge.

The other auxilary feeder is carried directly through, and a single tap connection is made from the feeder through the circuit breaker to the bus-bar. Upon the next bridge these conditions are reversed, so that each auxiliary feeder is divided into 4-mile sections. This arrangement provides a maximum flexibility of control.

At a number of points along the road, where there are numerous side-tracks, it is necessary to provide extra long bridge supports. Fig. 6 represents one of these long bridges, which is designed to cover 12 tracks. The catenary cable insulators are attached to the lower members of the truss.

Both rails of all tracks are bonded by means of No. 4-0 compressed terminal flexible bonds placed around the fishplates. The trolley itself consists of standard No. 4-0 grooved copper.

Whenever one track diverges from another a section insulator is inserted in the trolley wire. Insulators are also inserted in the catenary cables supporting the diverging wire between parallel tracks. The diverging trolley wire is connected to the main wire by means of a frog of standard design, and in order to prevent the contact shoes on the locomotive from catching, deflector wires are placed in the angle between the trolley wires. These deflectors are carried by yokes secured to the trolley wire and are attached to yokes at the rods, which are fastened to the catenary hangers. There being a certain amount of flexibility in the overhead trolley system, when the bow is pressed upward against the contact wire this wire is raised above the level of the other contact wires in the immediate neighbourhood. Thus, certain portions of the short length of trolley wire used to interconnect the two main trolley wires at cross-overs would tend to remain in a plane below that of the active trolley wire as the locomotive passes this point. The deflector wires are designed to tend to cause the cross-over trolleys and the main trolley to be raised partly in unison by decreasing the upward movement of the main trolley and increasing the upward movement of the cross-over trolley. The contact bow of the trolley mechanism on the locomotive is given a certain amount of upward curvature towards the centre, so that the bow has no tendency to catch in either the cross-over trolley wires or the intermediate deflector wires.

The New York, New Haven and Hartford Railroad Company, whose overhead equipment is described above, began to run regular electric trains last July, thus marking the inauguration of a new era in the development of American main-line railways by alternating current.

The management of the railroad decided some years ago to investigate electric traction with a view of substituting the new power for the steam locomotive. About a year ago, it was decided to instal the alternating-current single-phase system, and a contract was made with the Westinghouse Company for the construction of thirty-five locomotives of this type. Preliminary runs, tests, and trial trips were made on the new line for months. The railroad company, being satisfied with the result of these trials, decided to throw the electric road open to the public, and the first electric train on the road left the New Rochelle station for New York on the morning of July 24th. The service has begun with thirty-five 1000h.p. locomotives, each capable of pulling a train of ten coaches at an average speed of seventy-five miles an hour.

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

Coal Handling in Small Plants.

H. S. KNOWLTON.

IN very small power plants it is difficult to generate current with the same economy per kilowatt-hour which is expected of large installations. The principal reason for this is the absence of methods of operation efficiently applicable to the production of power on a wholesale basis. Highly organized equipment designed to work economically on a large scale with expensive supervision is too costly for the plant of a few hundred kilowatts rating, and even with installations of two or three thousand kilowatts there is need to scrutinize fixed charges pretty carefully before deciding to invest in superheaters, economizers, forced-draft apparatus, mechanical stokers and automatic coal-handling systems. Plenty of cases come up in which the installation of one or more of these systems is desirable, but there ought to be definite figures behind each decision to use these auxiliary devices.

The small plant suffers from relatively high losses in the power-production process, referred to the output throughout the day. Direct economies in the use of fuel are difficult to secure, but much waste can be prevented by extra care that leaks in the high-pressure piping be stopped, by looking after the tightness of valves and traps, by using as far as possible the smaller engines for the lighter hours of the daily load, and by at least an annual calibration of the recording wattmeters on the switchboard. Anything which can be done to save labour without spending money for costly equipment is likely to pay well for all the time and thought bestowed upon it.

Particularly in the matter of handling coal one finds many small plants working under disadvantages. There is no blinking the fact that firing a boiler is not an easy job. Even the intermittent care of a domestic furnace is often a thorn in the flesh of the manager who cannot see why enthusiasm is lacking in the boiler room of his power plant. The conditions in not a few small boiler rooms are so unfavourable to comfortable work that it is not surprising that the coal consumption seldom gets down where it ought to be. The room may be wretchedly lighted and without any means of artificial ventilation; there are likely to be no facilities for washing, nothing but a couple of chairs with the cane bottoms gone, for the use of the firemen between whiles; the gravity delivery of coal or the installation of industrial railway tracks in the boiler room floor may never have been thought of; and finally, the chief engineer may not give the work of the firemen proper supervision for any one of a number of plausible reasons. All these things may seem impracticable to the hard-headed manager who believes that the tendencies of human nature to shirk disagreeable duties cannot be overcome by any species of welfare work, but it is the solid truth that they vitally affect the fuel consumption.

It is frequently possible in a small plant to store coal at a higher level than the boiler-room floor, perhaps outside the building. If this can be done one shovelling can be cut out. It is a great deal cheaper to dump the coal from the wagon originally above the boiler-room floor, where it has been hauled

by a couple of stout draft-horses, than to raise it by hand. If one or more chutes can be arranged to deliver the coal upon the boiler-room floor in front of the boilers, so much the better; but in such cases the chutes should be equipped with a discharging device which will deliver a fixed quantity of coal each time, with an automatic record of the number of deliveries. An old revolution counter, or even a discarded cash register, can often be pressed into this service.

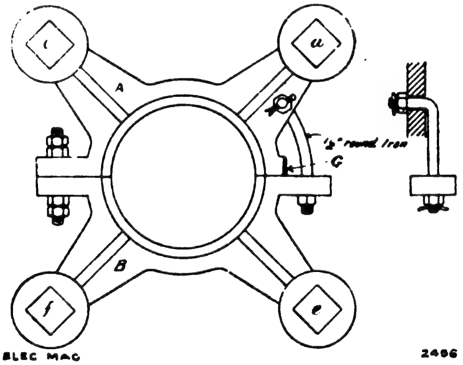
If the chute plan is not feasible on account of the distance of the raised coal pile from the boiler room, narrow-gauge cars can be installed to run between the coal bins and the boilers, and the passage of each car-load checked off either manually or automatically. In some small plants the firemen seem to be perpetually pushing low-capacity wheelbarrows between the coal pile and the boilers, whereas with the use of narrow-gauge tracks, perhaps graded slightly downward toward the boilers, a much larger quantity of coal could be handled per trip, leaving the firemen larger periods of rest for the supervision of the boilers. If the industrial trackage provided parallel to the furnace fronts is supplemented by a siding, the firemen can change directly from his car to the furnaces, utilize the empty cars for taking up ashes, shunt this ash car on the siding, and proceed with the charging operations from the next car. This latter arrangement also frequently does away with the necessity of extra labour during times of peak load, as often a sufficient number of cars can be loaded and placed on the track in the boiler room to carry the station through the hours of heavy output, thus cutting down the labour item. A minor point is the cleanliness possible with this arrangement.

With plants of 2000kw. or 3000kw. capacity, the use of mechanical stokers charged by hand is sometimes advisable, but it is questionable if in plants of this size it pays to sustain the extra cost of steel work and direct overhead coal bunkers designed for large storage capacity with mechanical conveyers. An arrangement which does away with the frequently high cost of substantial building construction for bunkers is to instal a travelling coal bunker which may be moved back and forth along the front of the boilers and set to discharge its load at any desired point. The use of a simple system of narrow-gauge tracks, the provision of plenty of light and windows which can be opened from the floor, with perhaps the use of an exhaust fan in the hot season, coupled with a few inexpensive arrangements for the personal comfort of the operating shifts, all mean better conditions in the boiler room, and they cost little in proportion to the beneficial results which they tend to produce.

It is specious to argue that improvements of this kind are not needed because they may not reduce the pay-roll of a single man. Labour must be paid for, and in so far as the physical tasks of the boiler room can be lightened lies the opportunity to utilize the intelligent fireman for more responsible tasks having to do with lasting economy of fuel and better pay.—*Elec. Rev., N. Y.*

Quick Repair to Dynamo Brush Gear.

An ingenious and effective emergency repair is described by "Helio" in the *Engineer-in-Charge*. While re-fitting rocker arms to a small generator which was wanted on load, one lug on the top rocker was snapped off by being twitched up too tightly. As no duplicate was to hand, the following



was resorted to:—A ½in. clearance hole was drilled about 2¾in. above the break and a piece of ½in. round iron, bent and screwed, as per sketch, was inserted through the bolt hole in the bottom rocker, the hooked end engaging in drilled hole in top broken part, split pins being fitted to each end instead of locknuts. The whole thing took about three-quarters of an hour, and ran for weeks until a new rocker could be fitted without inconvenience.

LIGHTING and Heating

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

*The Elements of Inefficiency in Diffused Lighting Systems.**

PRESTON S. MILLAR.

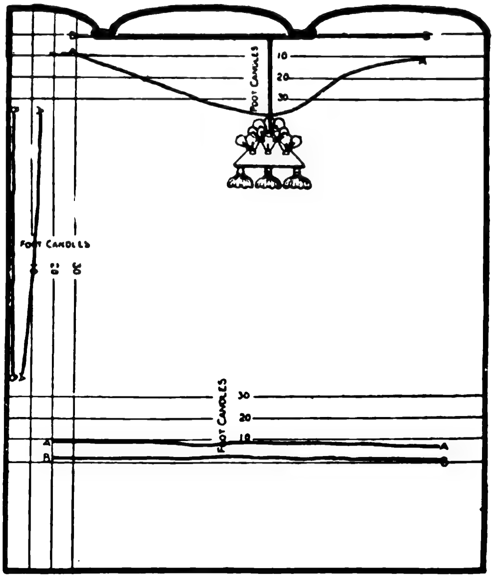
DIFFUSED lighting, in the sense here intended, is that form of artificial lighting in which the ceiling and walls constitute the reflecting and diffusing media through which the light is transmitted to the plane whose illumination forms the primary object of the installation. By direct lighting is meant the variety of methods in which the lighting of the ceiling and walls is incidental, and the bulk of the light is directed where needed.

For certain classes of work diffused lighting is credited with features of real or fancied merit. Generally it is characterised by reduced intrinsic brilliancy of light sources and by uniform distribution of illumination, said to be less fatiguing and more pleasing to the eye than direct lighting effects. To secure these advantages, efficiency is sacrificed freely. The extent of this sacrifice depends, of course, upon the nature and the object of the installation, being relatively small where the primary object is the brilliant illumination of ceiling or walls, and large when the primary object is utilitarian, as, for example, in desk lighting.

In this paper an endeavour is made to consider the elements of inefficiency which inhere in lighting systems of this character, in most instances basing conclusions upon measurements of illumination intensity.

The first element of inefficiency is the loss of a large proportion of the light in multiple diffuse reflection, which is necessary in this system of lighting. This loss has long been recognised, although but little information is available as to its extent even in specific installations.

To obtain material for this paper, temporary equipments for both direct and diffused lighting were installed in a room of which a vertical section and the lighting fixture are shown in the illustration below. The figure also shows illumination curves, plotted from tests, of horizontal illumination on the working plane, vertical illumination on



VERTICAL SECTION OF ROOM OF TESTS.

* Abstract of paper read before the Illuminating Engineering Society, Boston, U.S.A., July 30, 1907.

the wall, and horizontal illumination (plane inverted) on the ceiling. The tests were made at points about midway between one end of the room and the lighting fixture which was near the centre of the room. A sufficient number of lamps were burned in each installation to afford satisfactory illumination for reading. The diffused lighting curve illustrates the excessively brilliant illumination of the ceiling and walls necessary when sufficient light was obtained near the centre of the room.

In this temporary installation tests were made to determine intensity and efficiency of illumination on a horizontal plane 30in. above the floor. The average results appear in the following tabulation:

	Temporary Installation at Electrical Testing Laboratories.		Harlem Office of New York Edison Company.	
	System.		System.	
	Direct.	Diffused.	Direct.	Diffused.
Square feet of floor space......	176	176	1221	1221
Number of lamps	4	24	84	184
Type of lamp	All oval anchored filament incandescent electric.			
Average mean horizontal c.p..	10.2	19.4	16	16
Average watts per mean horizontal candle-power ..	3.53	5.16	3.10	3.10
Total watts	145	2398	4166	9126
Horizontal illumination, average foot-candles	1.02	3.29	5.44	3.84
Foot-candles per watt per sq. ft..	1.24	0.24	1.60	0.51
Relative effect of installation as a whole .. $\frac{\text{Diffused}}{\text{Direct}}$ ..	19%		32%	

In order to determine the relative efficiencies of two systems of lighting, it is necessary to consider separately the two prime elements upon which lighting efficiency depends. The first of these is the efficiency of the illuminants. In an electric lamp this is measured properly by the lumens* per watt. The second element which goes to make up lighting efficiency is the efficiency with which the light is utilised—that is, the proportion of the total flux of light which is effective on the plane considered.

* The lumen is the unit of light flux. It is the flux of light distributed through unit solid angle and is the mean spherical candle-power x 4 π.

So there are three expressions of efficiency, all of which are useful and none of which should be neglected. These are:

A. Efficiency of illuminants ... ... Lumens per watt.

B. Efficiency of light utilization ... Ratio $\left\{ \frac{\text{Lumens applied.}}{\text{Lumens generated.}} \right.$

C. Efficiency of lighting installation as a whole ... ... Foot-candles per watt per square foot, or lumens applied per watt.

If the illuminating engineer determines the average intensity of illumination on the plane which he selects as the criterion he can obtain the "lumens applied" by multiplying the average intensity of the illumination throughout the plane investigated by the area of that plane, expressing the intensity in foot-candles and the area in square feet.

A study of this character has been made in connection with the two installations referred to. The results appear in the following table:

	Temporary Installation at Electrical Testing Laboratories.		Harlem Office of New York Edison Company.	
	System.		System.	
	Direct.	Diffused.	Direct.	Diffused.
Total flux of light, lumens	424	4824	13938	30532
Flux on working plane, lumens ..	180	579	6642	4689
Efficiency of light utilisation......	42.3%	12.0%	47.7%	15.4%
Efficiency of illuminants (lumens per watt)	2.92	2.01	3.34	3.34
Relative eff. of systems: $\frac{\text{Diffused}}{\text{Direct}}$ ..	28 per cent.		32 per cent.	
Sacrificed to secure diffusion ..	72 per cent.		68 per cent.	

If the horizontal plane is made the sole criterion it appears that the efficiency of the diffused lighting system in the temporary installation is only 28 per cent. of that of the direct-lighting system. This figure is independent of the efficiency of the lamps installed and offers the correct basis of

comparison. The loss of light in these two diffused lighting systems, due to multiple diffuse reflection, amounted to about 70 per cent.

The second factor of inefficiency is the necessity for providing everywhere on the working plane an illumination which must approximate the highest intensity required at any point covered by the installation. With light which may be subjected to effective control, the necessary illumination is produced where the maximum is required, and efficiency is gained by permitting the intensity to approach a minimum at points where the high intensity is neither required nor desirable. Furthermore, in systems of diffused lighting the body and near-by objects obstruct no inconsiderable proportion of the light which would otherwise be effective.

The third factor is the ineffectiveness of rays falling at small inclinations upon the surface to be illuminated. With properly located light sources to provide direct lighting the proportion of light falling upon the working plane at sharply inclined angles is reduced to a minimum ; with diffused lighting this proportion is necessarily large at whatever angle the working plane may be placed.

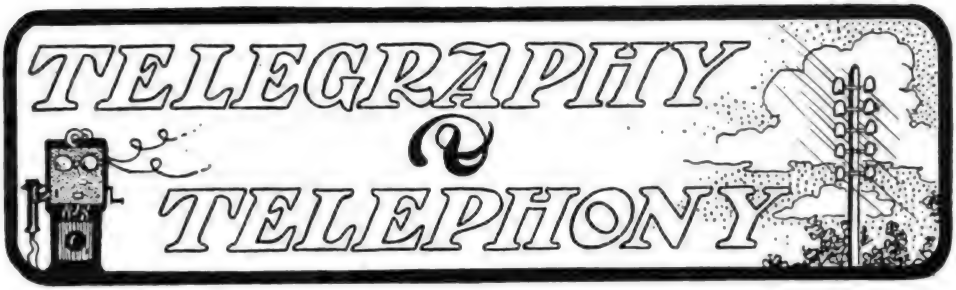
The fourth factor is the craving of the eye for higher intensities upon the working plane when surrounding objects are brilliantly illuminated. At the time when it was desired to investigate this question no suitable permanent installation was available. Consequently recourse was had to the makeshift installation which has been described. At various times individuals were brought into this room for purposes of experiment. Each was asked to seat himself in any position and location desired, the object being to secure conditions under which he could read with greatest ease and comfort. He was asked to hold a section of white newspaper at the angle which seemed to him best. The test plate of an illumination photometer was then placed immediately beneath the paper and parallel to it in such a manner that the paper could be removed and the intensity of the illumination which had been produced upon it could be measured without other change in conditions, the reader remaining in his seat. While the location was being selected the illumination was kept at a low intensity, only one two-candle-power lamp being operated. With the direct-lighting system the illumination was then raised and manipulated until an intensity suited to the individual's taste was secured. The paper was then removed and the illumination intensity measured. Immediately afterward the illumination was reduced to the first condition with only a two-candle-power lamp burning, and after a short interval the diffused lighting system was tried, other conditions remaining the same. This was manipulated from the switchboard until the desired intensity had been produced and measured.

The investigation was not at all exhaustive, being calculated merely to establish the existence of certain effects.

Considering the average of ten observers, 65 per cent. higher intensity of illumination was required for reading with the diffused-lighting system than was desired when the direct-lighting system was used. Incidentally, it is of interest to note the extent to which observers differed with respect to the illumination intensity which was found to be satisfactory. This is brought out in the following table :—

	Direct Lighting.	Diffused Lighting.
Average intensity	2.73	4.45
Average difference from mean amount	.46	.99
Average difference from mean per cent.	17	22
Maximum variation above mean, per cent.	37	42
Maximum variation below mean, per cent.	31.5	42
Variation, highest above lowest, per cent.	100	142

It was found that if a placard was viewed at a distance of 8ft. or 10ft., thirty times as much light was required to enable an observer to read it as well with the diffused-lighting as with the direct-lighting arrangement. In this test large portions of the walls were within the angle of vision and exercised a powerful influence upon the eyes of the observer with both lighting systems. With the direct-lighting system the walls were relatively dark, influencing the pupillary action of the eye so that a low intensity upon the placard appeared satisfactory. With the diffused-lighting system they were brilliantly illuminated, and so affected the eye that a very intense illumination was required upon the placard.



For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Wireless Telephony: The De Forest System.

WHILE the telegraph transmits an electric current so interrupted as to correspond to signals, prearranged by a given code, and therefore requiring an experienced operator for both transmitting and transcribing messages, the telephone produces variations in the intensity of an electric current to correspond to the sound waves given off by the sounding body. The more refined quality of the waves required for the success of telephony is therefore the salient reason for the present short range of wireless telephony as compared with wireless telegraphy.

Wire telephony has never yet been successfully carried to a distance of 100 miles under water, the limit being something under sixty miles, due to the distorting effect of capacity, as under the ocean the electrically conducting wires and the surrounding medium, separated by a fraction of an inch of insulation, act as the two plates of a condenser. Wireless telephony with its present range of ten to fifteen miles therefore does not have to be extended to many times its present range to exceed that of submarine telephony.

Wire telephony on land, however, is practised commercially up to distances of 1500 miles, and is capable of being extended by sufficient expenditure of money to 2500 miles or even more. The greater separation of the wires in land work and the ease with which suitable loading coils may be inserted in the lines are the reasons why land telephony so greatly exceeds submarine transmission in its range of usefulness.

The question of wireless telephony is by no means new, as with the early advent of space-telegraphy it was but natural that wireless telephony should be considered. Many experimenters in this country, on the Continent, and in America have been at work on the problem for several years.

There have been many methods proposed for obtaining wireless telephonic communications, one of the earliest being that of Professor Bell's radiophone, where a selenium cell was placed in the focus of a silvered parabolic reflector and connected with a battery and telephone receiver. Selenium, as is well known, has the peculiar property of changing its resistance with changes in the amount of light which falls upon it. The effect of telephone currents superimposed upon the supply of the ordinary direct-current arc was next investigated and it was found that the arc responded very effectively to these high-frequency currents. Accordingly, Ernest Ruhmer, of Berlin, combined the so-called "speaking arc" in the focal centre of a powerful searchlight and a selenium cell in a parabolic reflector, and was able to transmit sound successfully up to seven miles, but his experiments do not seem to have come to very practical results.

Both these methods, and in fact any method which employs light waves for the transmission of intelligence, naturally have the objection that the amount of light which is being transmitted is liable to be materially affected by the condition of the atmosphere or by intervening solids. Further, they are limited as to distance, and the beam of light must be directed towards the receiving station. The apparatus is cumbersome, and

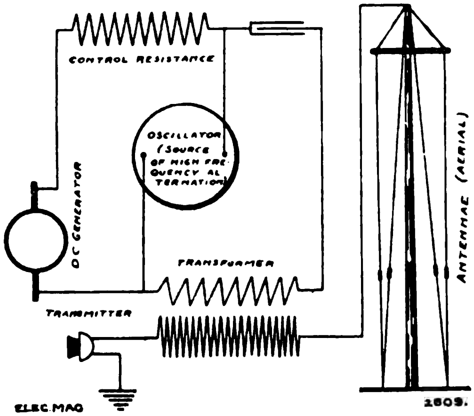


FIG. 1. TRANSMITTER CONNECTIONS.

would seem to be out of the question for marine work, where it is most essential to have the apparatus in its best working order during fogs, and where the exact direction of the receiving station is unknown.

It would appear that the best results are to be expected by working along the lines of space-telegraphy, or by depending upon electric waves, which are practically immune from atmospheric changes, and which radiate in all directions, and therefore do not have to be "aimed," so to speak, at the receiving station.

Dr. Lee De Forest, who is well known from his prominence in space-telegraphy, has been carrying on a most systematic and persistent research along these lines, and has devised methods and apparatus which are apparently successful. A description of his receiving and transmitting apparatus, as abstracted from *The Western Electrician*, will be read with interest.

In his usual arrangement, Fig. 1, a condenser, transformer and non-inductive resistance are connected in series to a source of direct current. The non-inductive resistance serves only to reduce the current to about five amperes. Across the primary coil of the transformer an oscillator or source of wave motion is placed. The oscillator sets up high-frequency electric currents in the primary of the transformer which are tremendously multiplied in the secondary coils, one end of which is connected through a microphone transmitter to ground, while the other end leads directly to the antennæ or aerial wires. Great care must be taken to instal the microphone transmitter at the point of zero potential, otherwise the instrument might be destroyed by the excessive currents which surge in the secondary wires.

At the receiving station, Fig. 2, another aerial is connected to one terminal of the secondary coil of a transformer similarly placed. The other side of the transformer is grounded. In series with the primary coils are connected a condenser and the Audion. (For description of the Audion, see THE ELECTRICAL MAGAZINE of December, 1906.) A condenser is also placed across the terminals of the primary coil.

The receiver itself, which Dr. De Forest invented when he was at work with the wireless telegraph, and which is one of the most sensitive of instruments, consists of a small incandescent lamp having a tantalum or other filament and two small plates of platinum within the bulb connected with platinum leading-in wires. The filament is raised to incandescence by a small storage battery, usually of about six volts, shown beneath the Audion. In the most recent instruments the two platinum plates are replaced by a grid and a wing. The interior of the bulb is highly exhausted, and when the filament is heated by the passage of an electric current, ionization of the rarefied gases takes place. When the electric waves reach this receiver through the grid the resistance of the interior of the bulb is changed and the telephone which is in the local circuit responds.

The oscillator may be any form of high-frequency interrupter, although in the apparatus here described an arc is used to supply an alternating current of a frequency so high as to be inaudible to the human ear. Upon these waves are superimposed the telephone currents of voice frequency which are carried along to the receiving station.

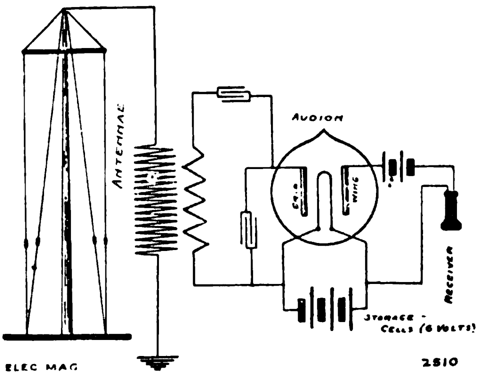


FIG. 2. RECEIVER CONNECTIONS.

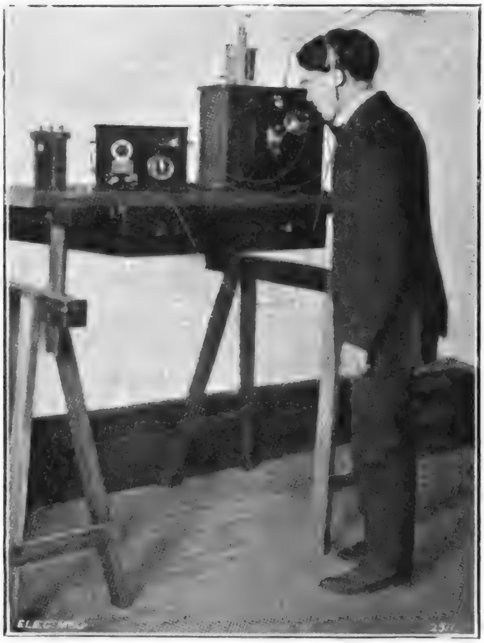


Fig. 3. Wireless Telephone Apparatus.

Although the talking currents which are sent through a submerged cable are distorted and so changed as to be wholly unintelligible when the distance between the stations exceeds the limit of fifty or sixty miles, these currents sent without wires, although possibly so weak as to be hardly discernible, are nevertheless perfectly clear, from which we may conclude that the range of communication can be increased by obtaining more powerful and more efficient receiving and transmitting apparatus.

The same advantages which telephony on land enjoys over telegraphy may be expected in wireless work; that it will find its greatest usefulness where it is essential to avoid experienced operators and where immediate actions are necessary.

The wireless telephone has the great advantage that both telephones may be so tuned for a maximum distance that the voices of those speaking are just distinct to each other, and it would be impossible for anyone beyond this limit to understand what was being said. The commander of a fleet could thus, for instance, talk *vivâ voce* with any one or all of the captains of his several ships without fear of a distant enemy catching the messages.

The practical development of this system has so far progressed that sounds produced in Dr. De Forest's laboratory in New York have been heard not only at other laboratories several miles distant, but distinctly at Quarantine, twelve miles away aboard the steamer *Bermudian*. The set, including transmitter and receiver, is shown in the illustration Fig. 3, and is so simple to handle that the most inexperienced can operate it after one or two lessons.

A key has to be used similar to those attached to the standard National Telephone instrument. This must be depressed when speaking, because the currents used are too great for the receiver to withstand and would either affect its sensitiveness or completely destroy it.

The De Forest Radiophone Company has already contracted with the Lackawanna Railroad Company to equip several of its ferry-boats with the new system, and it is expected that shortly contracts will be placed for the equipping of other ferry-boats. It is quite important that the pilots and captains of the several boats should be in communication with one another, especially in case of fog and at night.

It is not unlikely, then, that there is a commercial future for wireless telephony, but consideration shows that its use will be supplemental to the existing wire circuits rather than in opposition to them, and that it will occupy a new field for marine work, military operations, especially during war or manœuvres, for communication between island and mountains and in sparsely settled districts, and especially where temporary service is desired, as it can be installed at the shortest possible notice and maintained without the use of skilled operators.

*Telephonic Transmission Measurements.**

B. S. COHEN and G. M. SHEPHERD.

(Continued from The Electrical Magazine, June, page 388.)

Sinusoidal Current Producers.—Considerable difficulty has been experienced in obtaining a steady sinusoidal current of the frequencies required for telephone measurements. Arrangements depending on the reaction of transmitters and receivers have been tried, but without satisfactory results,

* Abstract of paper read before the Institution of Electrical Engineers, London, May 9, 1907.

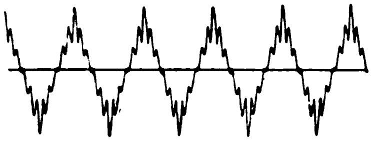
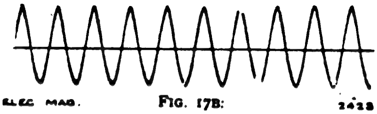


FIG. 17A



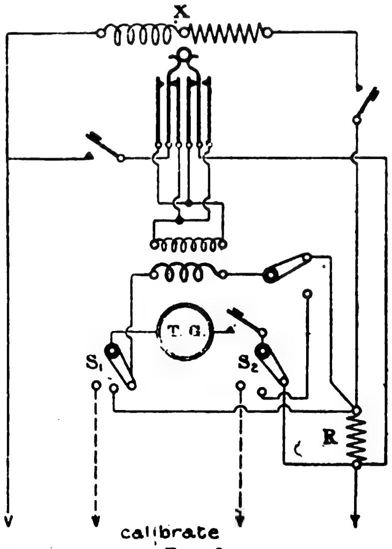
ELEC. MAG. FIG. 17B: 2423

as the waves are not by any means sinusoidal, and it is impossible to obtain the requisite steadiness. At present there appears to be no machine of a reasonably small size on the market for which the makers will give a sufficiently definite guarantee at the frequencies required.

As an example of the difficulty experienced, Fig. 17a is an oscillogram taken with such a machine of the wave-form on a non-inductive load. The suppliers were under the impression that this machine would give a closely sinusoidal wave-form. The machine used at present is a small inductor alternator, having an armature built up of ordinary slotted stampings, and gives a frequency of 800 ∽ at 960r.p.m. The output is small, but the wave is a very fair one, considering that no special shaping of the teeth was attempted. Fig. 17b is an oscillogram from this machine.

Wave Filter.—In order to purify the wave-form for very precise measurements, the peculiar property of the periodic loaded line already referred to has been utilized. By building up an artificial line, consisting of four or five sections, each associated with a condenser, inductance and resistance coils, it is found possible to practically abolish all upper harmonics and to leave the fundamental frequency desired. A wave filter of this description requires no tuning, and is safe over a considerable range of frequency, but naturally introduces a certain amount of loss.

Power Measurements.—The measurement of the energy absorbed by telephonic apparatus under working conditions presents considerable difficulty. The amount of energy is frequently exceedingly small, perhaps a few microwatts only, and is always a very variable quantity. The authors are unaware of any instrument directly indicating small fractions of a watt, which could be included in the receiver circuit of a telephone without radically changing the circuit conditions. An ironless two-coil wattmeter of the requisite sensibility offers a series impedance of many thousand ohms, and is, of course, quite inadmissible on that account. A thermal method seems to be the only alternative, and the hot-wire voltmeter method, due, we believe, to Mr. M. B. Field, was employed with some success. The connections are shown in Fig. 18. The instrument used to indicate the vector sum and difference of a potential was a Duddell thermo-galvanometer, operating with a 100-ohm heater. As only one such instrument happened to be available, it was necessary to employ a reversing switch to change the sense of the p.d. component. Switching arrangements were also provided to permit of current and p.d. measurements to be made independently, and to calibrate the galvanometer when required, by continuous current. Some difficulty was experienced in finding a suitable transformer for this work; a toroidal coil having a core composed of iron wire of about No. 40 s.w.g. was finally adopted. The dimensions of this core were approximately 11½cms. external diameter, sectional area 7sq. cms., depth 5cms. The two windings had about 2000 turns and 100 turns respectively, and the ratio of transformation experimentally determined ranged from 96.5 to 19.3, according to the number of secondary turns employed. A series of preliminary



ELEC MAG FIG. 18. 2424

Apparatus Tested.	Current	Actual Watts.	Apparent Watts.	Power Factor.	Effective.		∽
					L.	R.	
C.B. receiver	0.00695	0.00858	0.01435	0.600	0.0425	165	825
120-ohm receiver..	0.01160	0 02220	0.02930	0.760	0.0280	165	825
120-ohm receiver and induction coil ..	0.00220	0.00139	0.00247	0.562	0.0650	227	825
C.B. repeater, type 25c., with 150-ohm subscribers' line	0.00208	0.00149	0.00218	0·685	0.0690	320	800

tests was made with the previously described combination, using artificial loads made up of known non-inductive resistances, capacities, and inductances; and the results, though not of a very high order of accuracy, were yet encouraging when the difficulties were . considered. The thermo-galvanometer when worked up to its greatest sensibility was found to be extremely sensible to outside disturbances of various kinds, and much trouble was experienced from leakage and capacity currents in the test circuits. When the frequency is even no higher than 800 ∽ the term "non-inductive," as usually applied to resistances, requires qualification; and unless care be taken very erroneous conclusions may be arrived at. Some results using this apparatus are given in the above table:—

Test of sending end impedance of 30 miles of 20lb. paper telephone cable, far end open:—

Current.	Watts.	Power Factor.	Phase Angle.	Impedance.	∽
0.00658	0.0163	0.71	44° 48′	552 ohms	810

This is in good agreement with the theoretical estimate of the impedance of this class of cable, viz., 550 ohms and phase angle 450deg. All the above-described tests were made with current supplied by the small inductor alternator, previously referred to, using its natural wave-form.

In these days of the sovereignty of the two-coil wattmeter one scarcely cares to mention the three-voltmeter method, but as a matter of fact this method was found very convenient for certain measurements of the efficiency of induction and repeating coils. The instrument used was an Ayrton-Mather electrostatic voltmeter, having a readable range of about 1-10 volts. By switching over quickly into the requisite positions on the circuit quite consistent readings could be obtained.

An excellent point in favour of this voltmeter in connection with telephonic measurements is its negligible working current. It is a little disconcerting to find that the efficiency of conversion between the primary and secondary circuits of a telephone is of the order of 1 per cent., though when used as an ordinary transformer, at about 800 ∽ passing a current of a few milliamperes, the efficiency of the best type of induction coil is quite high, viz., about 72 per cent. The low efficiency in the former case is, of course, due to the large constant component of the current in the primary. A slightly higher efficiency was found for a coil of the toroidal pattern, but, unfortunately, improvements in the direction of a closed magnetic circuit have not so far proved feasible for induction coils.

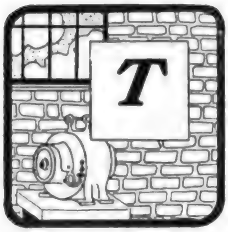
Telephone Line Equivalents Experimentally Obtained by Means of Voice Tests.— Attenuation constants for all the types of lines in use in this country were calculated in July, 1904, from the now well-known formulæ, taking into account the resistance, capacity, inductance, and average leakage, and the results were embodied in a table of equivalents, taking a 20lb. low-capacity cable as a standard. The results were experimentally verified in December and January, 1904 and 1905, the method for verifying being a simple one. This table of equivalents has already been published in Mr. Gavey's presidential address to the Institution.

Talk is transmitted over two lines alternately, using the same telephone instruments for both lines, one of which is a variable standard line and the other the actual line under test. The variable standard, which in the laboratory is an actual telephone cable capable of being varied in length from 0.1 to 52 miles, and which for portable purposes consists of an artificial cable calibrated against the laboratory standard, is adjusted until the talk over both lines as judged by the ear is balanced, and the ratio of length of non-standard to length of standard gives the equivalent.

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

*Notes on Transformer Testing.**

H. W. TOBEY.



TRANSFORMER testing has already received a great deal of attention, and considering the number and variety of articles upon the subjcct which have appeared, the ground would seem to be quite thoroughly covered, so thoroughly in fact that there would at first sight appear little more to add. But in view of the changes which have been constantly taking place and the rapid advance in transformer design, a general discussion of the subject at this time may be of value. Experience also has led to the adoption of certain methods in commercial transformer testing which for various reasons have proved satisfactory, so that a description of these with their advantages and shortcomings will, perhaps, prove of some interest.

Present methods of testing, like many other methods, are the result of gradual but constant development, in which the good has been as far as possible retained and the poor eliminated and replaced with something better. What was suitable for small transformers, for example, was found to be entirely unsuitable for large sizes, and methods which applied very well to transformers of low voltage had to be modified or entirely abandoned for high-voltage apparatus.

Generally speaking, it may be said that tests are required for the purpose of determining the chief characteristics of the finished apparatus, thus enabling it to be compared with the original calculations and designs, and with the guarantee. They may be classified as follows:—Conversion, polarity, resistance, copper loss, core-loss and exciting current, regulation, high potential,* high voltage,* temperature rise.

Conversion.—This test, while a comparatively simple one to make, is nevertheless extremely important, particularly where the transformers under consideration are intended for parallel operation or for delta connection to three-phase lines.

The most satisfactory method is, without doubt, one employing a standard multi-ratio transformer and a single voltmeter, provided the potential of the source of current supply does not fluctuate. Then, by applying a suitable common voltage to the high-tension side of the transformer under test and the standard, the two low-tension voltages may readily be compared and the true ratio obtained.

Where the supply is at all unsteady or where the ratio of the standard varies considerably from that of the transforme: under test, the two-voltmeter method is preferable. Accurate results may then be obtained by taking two sets of simultaneous readings, between which the instruments are interchanged to eliminate any dissimilarity between them.

The opposition method is also sometimes used to good advantage. With this, however, care should be used to see that the low-tension voltage of the standard and of

* Paper read before American Inst. Elec. Eng., June 26, 1907.

* Both of these are essentially insulation tests. The terms "high potential" and "high voltage" are used arbitrarily to distinguish between a test applied between primary and secondary windings and iron, and one applied across terminals of the same winding. The first tests the strength of the insulating barriers and casing, while the second tests the insulation between turns and between layers.

the transformer under test are exactly in phase.

As an additional precaution, single-phase transformers which are required to operate in parallel on single-phase circuits, or delta on three-phase circuits, also delta-connected phases in three-phase transformers, should be connected as they are eventually intended to operate, and a test made for circulating current. This serves as a check on conversion measurements and is important from the fact that a slight difference in voltage between windings is apt to lead to serious results.

Polarity.—The relative position of primary and secondary leads is ordinarily determined either by direct comparison with a standard transformer or by applying direct current to the high-tension winding, noting the position of positive and negative connections by means of a direct-current voltmeter, then shifting the voltmeter leads to the low-tension winding and noting the voltmeter deflection upon breaking the direct-current circuit. When testing large numbers of small transformers having approximately the same voltage and ratio, the first method is quicker and more satisfactory. For power transformers having as a rule widely differing voltage, the second method is usually preferable.

Resistance and Copper Loss.—In the measurement of resistance for the determination of copper loss and total resistance drop, the fall of potential method gives in general the most satisfactory results of any of the standard methods. The instruments required are less delicate than the galvanometer used in bridge measurements, may be readily calibrated, and will give accurate results over a wide range.

When measuring resistances of small transformer windings, the instruments come to rest very quickly and little time is required for taking the readings. With large transformers, however, unless special precautions are taken, this is seldom true; for even with the terminals of the opposite winding short-circuted on themselves, some seconds, or even several minutes, often elapse before the instruments settle, so to speak, to a final value, and until this settling has stopped readings will not indicate the true resistance.

Fortunately, this condition of affairs may be overcome by forcing through the winding under test a direct current of ten or twelve times that finally required for the measurement, and after a moment or two dropping it to normal before taking the reading. (Of course, during the passage of this increased current the voltmeter should be disconnected and the ammeter short-circuiting switch closed.)

While a delay of a few seconds or several minutes may do no particular harm at the time when cold-resistance measurements are made, it is extremely annoying during heat runs where measurements are taken at frequent intervals. Long interruptions of the load under these conditions are apt seriously to affect the final temperature.

Core-Loss and Exciting Current.—The influence of wave-form upon core-loss and exciting current has already been carefully investigated, and the importance of using a sine-wave source of current supply is well known. It is doubtful, though, if all fully realise how far from a sine wave the electromotive force of some generators really is under actual conditions of test, that is, when supplying core loss to transformers. This may occur, even though the wave-form of the generator is entirely satisfactory under normal conditions, from the fact that the wave becomes badly distorted at low power-factors which occur when transformers, particularly those designed for low frequencies, are operated on open circuit. The extent to which this distortion may reach and its effect on core-loss and exciting current are clearly indicated in the accompanying curves and data which follow.

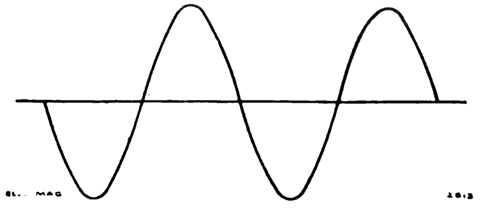


Fig. 1.

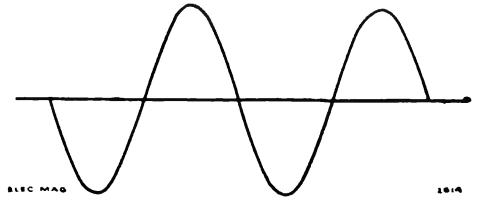


Fig. 2.

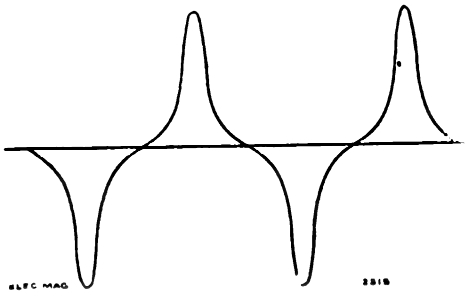


Fig. 3.

The curve, Fig. 1, was taken on one of the generators in question while on open circuit. The curve, Fig. 2, was taken on the same machine while furnishing core-loss and exciting current to a transformer. It will be noted that both approximate very closely a sine wave. The oscillograph curve shown in Fig. 3 was taken while a generator, having a very peaked wave, was exciting the same transformer at the same voltage. The resulting core-loss and exciting-current measurements are given as follows :—

First case, sine wave, core-loss 1177 watts, current 33.5 amperes

Second case, peaked wave, core-loss 924 watts, current 15.4 amperes.

By comparing these sets of readings it will be seen that in changing the source of supply from one giving very nearly a sine electromotive force wave to one giving a peaked wave, the core-loss decreased to 79 per cent. and the exciting current to 44 per cent. of the original values.

Another transformer measured under conditions shown in Fig. 3, and again under conditions indicated by Fig. 4, required respectively 5500 and 7325 watts core-loss and 25.3 and 47 amperes exciting current, an increase of 33 per cent. and 87 per cent. respectively. These readings show the variations which may occur with peaked waves of the same general character.

These figures clearly indicate the importance of referring all measurements to a standard form of wave. At first sight the peaked wave would seem to have some advantage over the sine wave, owing to the lower core-loss and exciting current values which result. After all sides of the question are considered, however, including among other things the effect of wave-shape on insulation strains, &c., a sine wave electromotive force is undoubtedly the best. And what is equally important, the generator should not only maintain the standard form on open circuit and on non-inductive loads, but also on low power-factor inductive loads, *i.e.*, under the conditions of test.

In the measurement of core-loss on three-phase transformers the windings across which the readings are taken should be Y connected and the opposite windings left open in case they are intended for delta connection. Otherwise the circulating current due to unequal distribution of flux in the core and to the short-circuiting of the odd harmonics will show up as an increase in core-loss, thus giving incorrect results. In case the transformer windings on one side are delta connected, and for any reason cannot be changed, it is preferable to connect both sides in delta before taking the core-loss measurement. The resulting circulating current will then occur in two windings instead of one, and being proportionally less, will produce smaller disturbing losses in the copper than if but one winding alone is delta connected.

Regulation.—In general it is now customary to determine the regulation of a transformer by one of the several methods which require impedance measurements with one of the windings short-circuited on itself, this having entirely superseded the old way of measuring the voltage with transformer free and loaded.

Here, too, it is important to employ a generator which will give a sine wave at low power-factor loads, for while it is true that the wave-shape does not affect the measurements so seriously as those mentioned under the preceding heading, nevertheless the variation is fairly well marked.

High-Potential Test.—On low-voltage transformers this test is not a difficult one to apply correctly, but where the voltage is high the question is entirely different, and the chance for error is large. This is chiefly because of the absence of a suitable means of measuring high potential. To be sure,

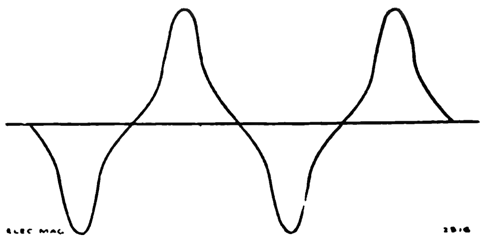


Fig. 4.

either the conversion method or the spark-gap method may be used, though both are open to criticism. Individual conditions alone can determine which is most suitable.

If the testing transformer has extremely close inherent regulation, and the charging current under conditions of test is but a small proportion of its normal current capacity, it is reasonably safe to rely upon multiplying the low-tension voltmeter reading, and to consider that this times the ratio of conversion is an approximate indication of the high-tension voltage. If these conditions do not exist, the spark-gap method must be relied upon. It should be used, however, with great care.

As the conditions under which the testing outfit operate are changed entirely by the introduction of the transformer under test, it is obviously not right to measure the high-tension voltage by spark-gap before this transformer is connected. On the other hand, if the transformer is connected in, together with the properly adjusted spark-gap, and the voltage is raised until the latter arcs over, high-frequency oscillations almost invariably occur and result in a rise in voltage. The final value of this voltage may be considerably higher than that required, resulting possibly in an uncalled-for breakdown of insulation.

Such a disturbance may be overcome in one of two ways, both of which have been tried with satisfactory results. The first consists of inserting in series with the gap a high resistance,* the presence of which prevents the occurrence of a high-frequency disturbance when the spark-gap breaks down. The only precaution necessary in the use of this auxiliary resistance is the calibration of the spark-gap with the resistance in series, as its presence will in general increase the effective value of the gap. In other words, the distance between needle-points, as given in the standard Institute table, may need to be decreased by from 5 per cent. to 10 per cent. to obtain correct results.

The other method referred to above consists in making all connections for the high-potential test and placing the spark-gap across the circuit, the gap previously having been set, however, for a somewhat lower voltage than that required, two-thirds for example. The voltage is then increased, and the low-tension voltmeter reading is noted at the moment the spark-gap breaks. The gap is now disconnected and the electromotive force again raised until the voltmeter reading, in the case cited, is 50 per cent. greater than before. The desired potential is thus obtained with fair accuracy without any disturbance in the circuit.

The importance of using a sine-wave generator for supplying current to the testing transformer is hardly to be questioned. Otherwise, it will be extremely difficult to obtain the desired testing strain.

As to varying the voltage of the high-potential transformer, several methods are possible, including the use of a variable resistance, a variable reactance, or changing the excitation of the generator field. The first, except perhaps in the case of low-voltage tests on small apparatus, should not be resorted to, as it has a very disturbing effect on the wave-form. The second gives more satisfactory results in this respect, and serves very well when the required range is not too great. In general, the last method, which is that of varying the generator-field excitation, is perhaps more often used, chiefly because it enables the voltage to be varied gradually over a wide range. Low field-densities, however, are apt to lead to armature reaction if the machine is furnishing anything like full-load current, so that even with this method some distortion of wave-form may result.

A discussion of this branch of the subject would hardly be complete without some reference to the effect which the time of application of the high potential has on the resisting strength of insulation. In other words, if an insulating material will safely withstand 50,000 volts for one minute, what potential will it withstand if the test is continued for five minutes and what will it resist indefinitely?

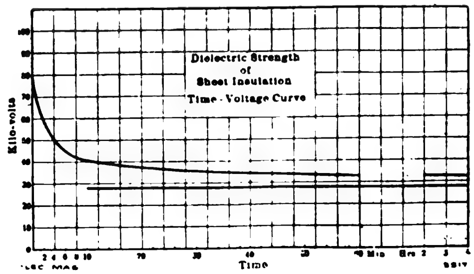


FIG. 5.

* For potentials ranging from 100,000 to 200,000 volts, a resistance consisting of a dozen U-shaped glass tubes ½in. inside diameter and 2ft. in length will be found satisfactory. These should be mounted in a suitable rack, filled with water and connected in series.

D

This relation between time and voltage is fairly well represented by the curve shown in Fig. 5. This was obtained from a series of tests on sheet insulation, potential from a 60-cycle sine-wave generator being applied to two brass discs arranged on opposite sides of the test piece.

It will be noted that for periods of one minute the sample safely withstood a pressure of 65,000 volts. For five-minute tests it was necessary to lower the pressure to about 70 per cent. of this value, or 46,000 volts; while in order to resist the test indefinitely, the applied voltage had again to be lowered to 27,500, or about 40 per cent. of its original value.

These figures can hardly be taken as general, for they change considerably with different kinds of insulation, and the resulting curves assume widely varying forms. In most cases the reduction in strength as the length of the test increases is much less than indicated above, so that in comparing the instantaneous test and continual test, for example, the reduction is nearer 50 or 60 per cent. instead of 70 per cent. as in the sample noted. These figures serve to emphasize, nevertheless, the undesirability of long-continued strains, and tend to confirm the advisability of retaining the present one-minute standard.

High-Voltage Tests.—The test which determines the strength of insulation between turns, between layers, and between leads is equally as important as the "high-potential" test just referred to. If the transformer windings withstand double voltage, or, in the case of lightning transformers, triple voltage, their internal condition is reasonably well assured.

In applying this test it is usually advisable, and in most cases necessary, to use a frequency considerably higher than that for which the transformer was designed; otherwise the exciting current will become so excessive as to make it difficult or even impossible to obtain the desired increase in voltage.

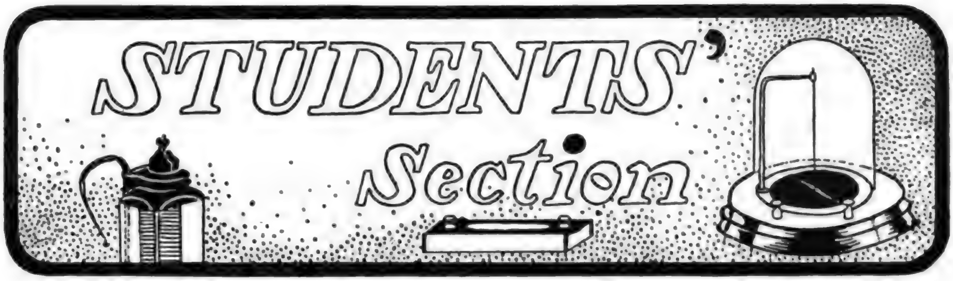
In general, satisfactory results are obtained by employing a frequency as much above that for which the apparatus is designed as the test voltage is above normal terminal voltage. With a 60-cycle transformer under consideration, for example, 120-cycle current gives good results for double voltage tests, while 180 cycles is usually satisfactory for triple voltage. A 180- to 200-cycle generator answers very well therefore in the majority of instances.

Temperature Tests.—Except perhaps in the case of special tests on small transformers, or where a single transformer is to be tested, the differential method of applying load for the temperature test or heat run is the most satisfactory and probably the one most universally used. The total losses occurring are in general somewhat in excess of those which would take place if the transformer were normally excited and loaded on a dead resistance, or if it were operating under actual conditions of service; therefore the results are always on the safe side.

While it is perhaps preferable to make this run at normal frequency, both on the exciting and loading side, still this is not absolutely essential to satisfactory results. In fact, two entirely different frequencies may be employed if desired, it merely being necessary to adjust the exciting voltage so as to obtain what has already been found to be the true core-loss at normal, or rated, frequency, and then to feed the required current into the other side.

The resistance readings taken at intervals during the run for the purpose of temperature determinations should obviously be made with the shortest possible delay in view of the necessary removal of load at such times. It is here, therefore, that the precaution mentioned under the subject of "Resistance and Copper Loss" is most useful. By observing this, and by employing suitable arrangement of double-throw switches to which the measuring instruments and source of direct-current supply may be permanently connected, the time required to take a resistance reading is reduced to a minimum.

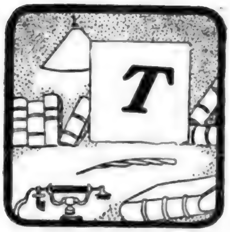
General.—The order in which tests should be made depends more or less upon local conditions, so that no fixed rule can be given, nor, in fact, is one necessary. The general order in which the tests have here been described is perhaps as good as any. It has the advantage of placing the heat run at the end, so that in case any part of the insulation has been injured by previous tests the fault will become evident while the transformer is under load and operating under service conditions. It is sometimes considered advisable, however, after the heat run has been finished, to repeat the measurements of core-loss and exciting current. Any defect in the winding will then be apparent at once.



Students should refer to the World's Electrical Literature Section for classified list ot articles of special interest to them.

A Problem in Phasing.

J. P. JOLLYMAN.



THE following problem in phasing and its solution is presented as an illustration of a method by which the solution of other similar problems may be worked out more quickly than by the usual methods.

Two 60kw. three-phase lines fifty miles long were brought into a sub-station from the bus-bars of another station. One line was in regular service when the second was brought in, and was carrying a load that could not be interrupted. The corresponding wires of the two lines were not known. It was necessary to find them so that the two circuits could be operated in parallel.

Fig. 1 shows the wiring at the sub-station. It should be noted that the step-down transformers in banks I. and II. are star-connected on the high-tension side with grounded neutrals, and delta connected on the low-tension side. *A*, *B*, and *C* are the phases of the circuit first in service. *D*, *E*, and *F* are those of the second circuit. With switch

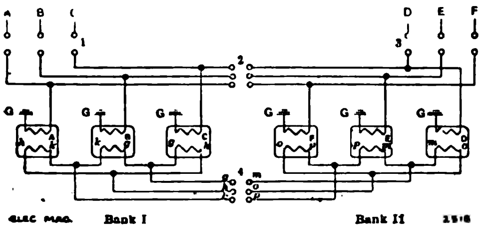
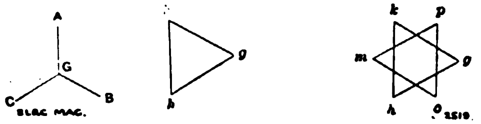


FIG. 1.



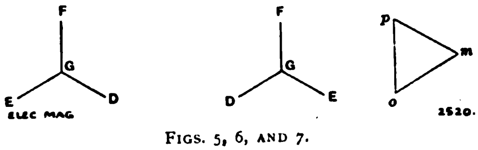
FIGS. 2, 3, AND 4.

3 open and 2 closed, 4 could be closed. This shows that banks I. and II. are alike in every respect.

Let Fig. 2 represent the high-tension star of bank I. Then Fig. 3 will be the corresponding low-tension delta. The method of constructing this delta is important, and is as follows: The vector of low-tension voltage of any transformer is assumed to be parallel to, and in the same direction as, the vector of high-tension voltage. Thus *kh* is parallel to *AG*, *gk* to *BG*, and *hg* to *CG*. From this, Fig. 3 is drawn from Fig. 2 and Fig. 1.

Tests across switch 4 with potential transformers, when power was applied to bank II. from the line *D*, *E*, *F*, showed that the two deltas of low-tension voltage had relative positions as shown in Fig. 4. This was determined by obtaining full voltage from *p* to *h*, half voltage from *p* to *k* or *g*, and corresponding voltages from *h* and *k* to the other points of the other delta.

Now construct the high-tension star from the low-tension delta *p*, *o*, *m*. The line *po* is parallel to and in the same direction as *FG* from Fig. 1. This fixes *FG* in Fig. 5.



FIGS. 5, 6, AND 7.

The line *mp* is parallel to and in the same direction as *EG*, and *om* as *DG*. Thus Fig. 5 is determined.

It may now be seen by comparison of Fig. 5 and Fig. 1 and Fig. 2 what must be done in order that the circuits may be paralleled. A reversal of *E* and *D* would cause the star and delta of bank II. to be as shown in Fig. 6 and Fig. 7. This would permit the lines to be parallel either at switch 2 or 4, since *g* is across switch 4 from, and should be in phase with, *m*, *h* with *o*, and *k* with *p*. The change mentioned causes this to be the case. An actual test showed that this change, as deduced from the diagrams, was correct.

It is believed that a solution of many of the problems in phasing may be more quickly obtained if methods such as given above be used to indicate the necessary changes.—*Elec. World.*

On Testing.

V. W. SHEAR.

STUDENTS and apprentices who expect to become engaged in the testing of large electrical apparatus will find these general notes of some value. They occurred in a short article which appeared recently in the *Electric Journal*, reviewing briefly some of the practical points entering into the routine of this shop-testing work and which go far to make it rapid, accurate, and successful.

Assuming that one has just arrived upon the testing floor and sees around him a great complication of machines, switchboards, cables, and men, the great question in his mind is: Why is each one doing a certain thing and how will *he* do it? He is told to do some very simple thing, such as take speed (so simple that many never learn to do it accurately) or hold the voltage steady by means of a rheostat. He gets a chance to look around him and to answer a few of the whys and hows. Very soon he must make connections more or less complicated and read meters. Using all judgment with regard to troubling busy men, the questioner will be wise to lose no time in tracing out exactly the circuits that are being connected up and learning what results are expected from that particular way of doing it. He is sure to need that knowledge in a short time.

There is no aid to intelligent work like making diagrams of all circuits on switchboards, tables, relays, &c., which are not in plain sight. They need be only rough sketches that can be carried around ready for instant reference. One is then sure of the connections which he is making. His previous training and experience must tell him whether or not they are the correct connections. It is often of great advantage to have sketches of the circuits on which one may work later. This knowledge will be found valuable in making the work easier and better, in giving evidence of foresight, and in increasing one's efficiency. Accuracy is much easier when made a habit from the start and consistently followed out.

A good tester never anticipates results. It is his chief temptation, however. The most staid old apparatus will occasionally give most unlooked-for results. Such results must not, through laziness or fear of criticism, be corrected to look like usual results; the cause should be investigated. Judgment should also be exercised regarding the precision required in commercial testing. Meters should not be read to four figures when two figures are sufficiently accurate and more rapid.

The beginner expects ideal conditions. He finds them quite otherwise. Certain apparatus is out of repair; the voltage from the power-house is not always steady; lights do not always burn; someone else always has the meters, rheostats, and cables that are needed: the whole place is wrong and ill-managed, and valuable time is therefore spent in grumbling. Are you sure that, if burdened with the responsibility of accomplishing a vast amount of work accurately, rapidly, and withal economically, the department would be in better shape under your management?

Many men fail to do their best work because of an almost utter lack of any feeling of responsibility. A man never knows when the foreman is asking the man in charge of a squad how that man is getting along. Aside from the general advisability of always doing one's best, it is not safe to do otherwise, if desiring promotion.

There is no work calling for such a mingling of caution and firmness as the testing of large machines. Caution is required when deciding just what to do; but above all things do not allow caution to stand in the way of throwing each switch as though you meant something by it, nor keep

you continually hesitating. There is no safeguard against burns and accidents like eternal vigilance and constant carefulness, combined with a positive way of carrying out your decisions. These qualities will afford the surest means of acquiring a well-grounded self-confidence as well as the confidence of your superiors and associates.

Care of Generators.

THE following notes on the care of dynamo machines are taken from Part IV. of a series of practical articles appearing in *The Electrical Review, N.Y.* There are many text-books devoted solely to this subject, but the more important points are here summarized to good advantage.

One of the first points to be considered in connection with the care of a dynamo is cleanliness, and better results can be obtained if cleaning is done immediately after shutting down than if allowed to stand for some time, as the oil and grit are more easily removed when warm. An air-blast supplied through a flexible hose is one of the best means of reaching the more inaccessible parts of a machine, and the necessary apparatus consists of a small motor-driven pump, which may be portable if desired.

It is a good idea in the case of small and medium-sized machines to provide a canvas cover for placing over them after cleaning in order to prevent dust from settling upon them again.

Before starting up a machine, a careful examination should be made to see that all of the connections are right, and also to make sure that no tools have been left lying about. Note if the brushes are all set and have the proper tension. It is often customary to bring dynamos to their full speed before lowering the brushes into contact with the commutator. This is unnecessary unless there is danger of the machine being turned backwards, which would damage copper brushes.

The main switch connecting a dynamo into the circuit should not be thrown in until the dynamo is "built up"—that is, operating at the required voltage indicated by a voltmeter or a pilot lamp. This does not apply, however, when operating on an independent circuit, for it then does no harm to have the circuit on and allow it to build up with the machine.

A heavy load should never be thrown upon a generator suddenly when it is possible to avoid it; instead, the load should be gradually increased by means of circuit switches, or if connected in multiple with other machines, the shifting should be done by degrees.

New machines being operated for the first time require special attention, and it is well, when possible, to run them for a short time at less than full load. Probably overloading causes as much trouble as any one thing, and should therefore be guarded against as much as possible. Iron and steel tools which are subject to the action of magnetism should be kept away from a dynamo when running to prevent their being drawn in among the moving parts. Copper or brass oil-cans should be used for the same reason.

If it is desired to stop a generator operating in parallel with others, gradually remove the load until its ammeter indicates little or no current, then open the switch. Under no circumstances should the speed be lowered or the magnetism weakened before disconnecting.

If this were done the machine would probably run as a motor, taking its current from the main circuit, which might cause serious damage. If a machine is operating alone on a circuit, gradually decrease the speed and allow it to stop without touching either the brushes or switches. Do not switch out a dynamo at full or partial load, except in case of emergency.

Never lift a brush while a dynamo is generating current except when there are other brushes in contact upon the same side. The cause of sparking at the brushes varies in different types of machines. Some of the more common reasons for this difficulty in direct-current multiple machines are as follow: Brushes not set at the neutral point, current overload, rough commutator, open coil in armature, short-circuited coil, leak from coil to frame, weak or uneven magnetism, poor brushes, or excessive vibration of the machine.

When sparking is caused by an improper position of the brushes, it is easily remedied by shifting them either backward or forward until the neutral point is found. This will be evident from the action of the machine. An overload will produce sparking, as probably the capacity of the commutator and brushes may not be sufficient, and in this

case there is no remedy except to reduce the load.

It is not difficult to keep a commutator which has no original defects in good condition if properly cared for from the start; but if allowed to get rough and full of ridges it takes considerable time and care to bring it into proper shape again.

An open coil can be detected by a spark which will appear to travel almost around the commutator. The defective coil can sometimes be found by noticing which bar is most damaged by the spark. If there is not time to repair it, the dynamo may be operated for a short time without damage by connecting the two bars together between which the open coil exists. A break usually occurs where the wire is joined to the commutator bar, and is therefore easily located and repaired. A short-circuited coil may be detected by holding a piece of iron between the pole-pieces and in such a way that it will be influenced by the magnetism. The fact that a defective coil exists will be shown by a sudden variation in the pull at a given point in each revolution. A short-circuited coil will heat much more than the others, and is very likely to burn out.

A leak from the windings to the frame is generally found by means of a magneto bell. Weak or uneven magnetism will cause sparking at the brushes and also reduce the electromotive force when running at the normal speed.

The brushes should be kept properly fitted and no ragged edges be allowed to form. They should be set on the commutator in such a way that the intended contact surface shall be in contact at all times.

Excessive heat exists if the armature or field coils become so hot that the hand cannot be kept upon them for a short time without discomfort.

Good Advice.

The young engineer must, as far as ever possible, combine his works or college lessons with a close study of modern commercial practice.

It has been said that some men have the engineering instinct. However that may be, it is the persistent practice of hand and eye, the extreme breadth of view, and knowledge of all things built and controlled by man which develop and proclaim the leading engineer.

There never was a good engineer yet who had not acquired an intimate knowledge of the principles underlying the construction of all things built or the operation of any machine.

It is indeed essential that the early years of an engineer's career should be spent in gaining as accurate and complete a knowledge of the entire field of electrical application as possible.

This is an age of specialists. No student can be or should attempt to be a specialist from the beginning. It is only after years of practice and with a full knowledge of all phases of electrical engineering that the individual, by natural bent or circumstance, becomes a specialist.

Therefore let the aspiring electrical engineer see to it that he stick not too slavishly to the exercise-book or bench; there is a constant look-out on the world's practice to be maintained. The class-room lesson is thus the more easily learned, and the probationary period is rightly, because most profitably and economically, spent.

The electrical industry moves forward with great and rapid strides, and as a consequence no electrical engineering text-book is right up to date or complete; in fact, recent books will give information which, not being ear-marked as of mere historical interest, tends to be misleading.

"A Monthly Record of Electric Progress" is the sub-title of The Electrical Magazine. A glance through the magazine substantiates the truth of its title. All branches of the electrical industry are dealt with systematically therein; it is fully illustrated with useful views, diagrams, and scale drawings.

The reading of its pages indicates that The Electrical Magazine is replete with valuable facts: it is not a newspaper, but is a real magazine, in magazine form, to be bound and retained as an invaluable book of instruction and reference ahead of all text-books because it appears month by month and presents an accurate technical account of the very latest doings in electrical engineering practice and invention the world over.

The ideal publication for the young electrical engineer is therefore The Electrical Magazine; its regular perusal forms an essential part of his training.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

The Engineering and Machinery Exhibition.

THE following notes of the machinery and plant to be seen at the Engineering and Machinery Exhibition now being held at Olympia are intended merely as a guide to the reader as to the scope and nature of the exhibits. It is not claimed that all exhibits are mentioned here, or that every exhibiting firm is included, but these short notices may be taken as conveying a good idea of the valuable nature of the exhibition as a whole. The October number of THE ELECTRICAL MAGAZINE will make a special feature of the exhibition; fully illustrated technical descriptions of the most noteworthy exhibits will there be dealt with in detail. Those readers who are unable to be present at Olympia will be able to judge from the following brief collection of notes that there is much which is well worthy of being placed prominently on record in our pages.

Power Generating Plant, Auxiliaries and Accessories.

W. H. Allen, Son, & Co., Bedford.

EXHIBIT consists of three specimens of this firm's well-known make of high-speed steam engines. One of these is a three-crank, three-cylinder, compound vertical type as suited for direct connection to electric generator. The engine is capable of developing 300b.h.p. at 450r.p.m., and is suitable for steam pressures of 100–200lb. per square inch, condensing or non-condensing. The valves are of the piston type of special design. Forced lubrication is employed, the engine being provided with a valveless oil pump fitted within the crank chamber, and driven from the high-pressure eccentric.

The second example is a 220b.h.p. 450r.p.m. two-crank compound engine suitable for steam pressures of from 100–200lb. per square inch. Another two-crank compound enclosed engine is also shown. This is capable of developing 130b.h.p. when running at 500r.p.m., and is also suitable for steam pressures of 100–200lb. per square inch.

A specimen of the "Allen-Edwards" air pump is shown. Each barrel is 10in. by 7in. stroke, the pump being capable of dealing with 18,000lb. of steam per hour at 160r.p.m. The casings of the pump are of cast iron, the working barrels, valve seatings, and guards being of gun-metal. The bucket rods are of bronze; the valves are of the well-known "Kinghorn" type.

Three examples of Messrs. Allen's well-known line of centrifugal pumps are shown. These include one of the low-lift belt-driven type capable of delivering two to three tons of water per minute against a head of 35ft. The second is a low-lift type capable of delivering 1000gals. per minute against a head of 70ft. when running at 980r.p.m. This pump has a guaranteed efficiency of 72 per cent. The third example is a medium-lift belt-driven pump capable of delivering seven to eight tons of water per minute against a head of 60ft.

Samuelson & Co., Ltd., Banbury.

The principal item of this firm's exhibit is a vertical type steam engine having

cylinder 8in. by 9in. stroke. This engine is fitted with piston valve, and is suitable for a steam pressure of 150lb. per square inch.

A Roots' blower of the "Acme" D2 size, discharging 270 cubic feet of air per minute at 400 revolutions, and also a Roots' "Acme" rotary pump, discharging 175gals. per minute at 250r.p.m. against a 50ft. head, are shown; these two machines are electrically driven by motors of Messrs. Siemens' manufacture. A portable forge fitted with a hand blower giving a discharge of 40 cubic feet per minute is also shown.

The Fairbanks Company, London, E.C.

A large variety of engineering machines, fittings, and appliances are shown by this company. The principal items are:—

A petrol engine of 7h.p. This engine is utilized for the driving of a power hammer and a hack-saw machine. The power hammer is driven by belt, is effective, and under easy and definite control. The hack-saw exhibits some novel features. It has an adjustable length of stroke, takes various lengths of blades, and has an automatic stop adjustable to any depth.

A Yale and Towne electric pulley block is shown. This useful appliance is suspended from a single hook in the same manner as an ordinary pulley block, and is operated by current which can be obtained from any convenient pair of lamp wires. Other pulley blocks are also shown.

Of general tools exhibited by this company there are a special line of hot forged twist drills, and a large assortment of stocks and dies, taps, wrenches, chucks, vices, &c.

Richard Hornsby & Sons, Ltd., Grantham.

A complete suction gas-electric outfit is shown in operation supplying current for the lighting of the exhibit. The engine is of the horizontal "Hornsby-Stockport" type, driving the dynamo through flexible coupling.

The Alexander Manufacturing Company, London, E.C.

The principal new appliances exhibited include examples of a burst pipe check valve, high-lift safety valves, and atomizers for the allayment of dust in coal mines. This exhibit also combines that of the

Mork Patent Pulley Block Company,
who show several specimens of their well-known blocks and lifting tackle, including the "Nonfrict" system of overhead runways.

Arthur Ross, Hotchkiss, & Co., Ltd., London, S.E.

The exhibit includes interesting working model boilers and circulators in glass, showing the automatic start and continuous movement of the circulation maintained by the Hotchkiss Automatic Circulator. It is shown that this circulator maintains a rapid movement of the water inside steam boilers independent of any movement produced by steam formation. The circulator also serves to separate out suspended matters and oil and grease, thereby introducing economies in steam raising and lessening the tendency to priming, &c. A very large number of these circulators are in use, and it is stated that in some cases the whole cost of the equipment has been saved during one year's operation. Various models to scale of steam boilers fitted with this appliance are shown. This firm makes a speciality of boiler compositions, and specimens of scale removed from boilers are shown. An improved steam trap is also being exhibited for the first time. This is known as the "Patros" trap, and its design is based upon the best features of the expansion and float types.

McPhail & Simpson, Ltd., Wakefield.

This firm makes a speciality of superheaters, and exhibits specimens of the parts used in their construction. Wrought-steel dished headers, tube plates, tubes in process of making and in various stages of assembling are shown. Specimens of tubes which have been in continuous work night and day for ten years in a Babcock & Wilcox water-tube boiler, and others which have worked for twelve years in a Lancashire boiler, are shown. A line of stop valves specially designed for use with superheated steam are also shown.

E. Green & Son, Ltd., Wakefield and Manchester.

Model of Green's improved patent fuel economizer (quarter actual size), containing 96 tubes, arranged on the modern principle in two groups with facilities for access to all parts. This model is fitted complete with top and bottom branch pipes, blow-off and safety-valve, and scraper gear; the latter is shown in motion, being driven by a small electric motor. This model represents an economizer suitable for one boiler.

Another model shown is of a Green's economizer containing 72 tubes in one group. The economizer is applied to a water-tube boiler plant, and is shown erected in position fixed over the main flue. The scraper gear of this model is also shown in operation, and is driven by a ¼h.p. electric motor.

A Green's horizontal high-speed engine of 3½in. cylinder as suitable for driving small power plant, gearing on economizers, mechanical stokers, conveyors, &c., is exhibited. Sample castings of economizer, tubes, top and bottom boxes, valves, &c., and a piece of burst pipe, burst at a pressure of about 3000lb. to the square inch, are also striking features of an interesting exhibit.

The Empire Roller Bearings Company, Ltd., Westminster, S.W.

This firm's specialities are well known in engineering circles. The exhibit in this case consists of specimens of the roller bearings as applied to various purposes. A working model is shown illustrating the action of the roller bearings when fitted to axles. Types of railway and tramway axle boxes, swivel and rigid shafting bearings, trolley bearings, also specimen cages and rollers, are displayed.

James Walker & Co., London, E.

A collection of the well-known "Lion" metallic packings for high-pressure steam pumps, &c., is shown, as well as a new jointing known as the "Walkerite," suitable for joints in steam, water, acid, ammonia, petroleum, &c., mains, special joints for motor engines, graphite lubrication bricks, "Wallico" cone gauge-glass rings, &c. A feature of the packings is that the firm has recently introduced, as a means of identification, a thin red line which runs right through them; this, being protected by copyright, together with a brass trade-mark label attached, guarantees the purchaser.

Newton & Nicholson, South Shields.

Specimens of Taylor's corrugated metallic packings are shown as made in brass, copper, gun-metal, nickel silver, nickel copper, and steel. This firm also exhibits specimens of snatch blocks and pulley blocks for chain, manilla, and steel ropes.

The Forced Lubrication Company, Ltd., Manchester.

Complete bearings and bushes fitted with Tilston's automatic forced lubrication system are shown. For demonstration a short length of shaft running at 400r.p.m. is mounted in two swivel adjustable bearings to which Tilston's system is adapted. A pressure gauge is fitted to one bearing to show the pressure necessary to lift the shaft to ensure it running on a thin film of oil; and on the other bearing a pipe connection is arranged to show the quantity of oil pumped.

These connections can be fitted in a few minutes without stopping the shaft, and by applying them periodically in practice, say every six months, when renewing oil, one can tell exactly what is going on inside the bearing.

The Albany Engineering Company, London.

A large assortment of power plant accessories, including lubricators, cocks, pipe unions, &c, are shown.

The Dexine Patent Packing and Rubber Company, Ltd., Stratford, E.

The Dexine patent packings are well known. A special feature of the exhibit is the patent metallic boiler feed-pump buckets, which will withstand temperatures of 350deg. F. and a working pressure of 500lb. per square inch. Specimens of the Dexine hydraulic ram rings, valves, sheeting, buffers, buckets, &c., and various other specialities are shown.

Cochran & Co., Annan, Ltd., Annan.

This firm of boiler-makers have a tasteful little stand exhibiting diagrams, photos, and other pictures of the Cochran Vertical Multitubular Boiler. In addition to two large hand-painted diagrams, which show the sectional and outside views respectively of the standard boiler, there are numerous smaller pictures designed to illustrate its points more fully, the modifications which have been made to adapt it to specific purposes, and various of the more striking uses to which it has been put in practice. One of the most interesting is that which shows the Cochran patent seamless furnace, which is flanged complete from a single plate without weld or seam of any kind. The portability of the boiler is illustrated by one mounted on trolley wheels for short-distance travel from point to point as may be required, as supplied to the Native Indian States; and by another fitted with strong road wheels for long-distance travel over such rough country as the Sahara Desert or the South African veldt. Another very interesting picture is one of six of these

boilers all linked together in battery which Messrs. Cochran recently shipped to China. This form of providing for the raising of steam was in this instance specially adopted owing to the convenience of being able to split up the battery into its six units and pack each into a springless cart—the only conveyance procurable over the endless mountain roads, as the destination of the battery was far in the interior of Chinese Asia. Other pictures deal specially with what Messrs. Cochran call their *multum in parvo* type, in which their standard boiler is specially modified for use on board ship, where the great value of space often leads to the undue contraction of the stokehold; and with another ingenious modification specially suiting the boiler for rail motor coaches—where the advantages of the vertical type are combined with those of the locomotive type. Great interest will also be shown in the illustrations which show this boiler specially adapted to utilize gases from furnaces, forges, or kilns, which have hitherto been wasted—thus ensuring an enormous saving in fuel, and incidentally putting an end to much of the smoke nuisance. In general, a glance over the many illustrations will also forcibly bring home to the visitor the very large number of sizes in which the standard boiler is built and stocked for immediate delivery, and the great variety of uses to which it has been put at home and abroad, on land and sea. Among the general advantages claimed for it are safety, simplicity, handiness, ease of cleaning, and the consequent excellent steaming, even where the water and fuel supplied are not of the first quality.

Pumps, Compressors, Rock Drills, &c.

The Lamp Pump Syndicate, Ltd., London, E.C.

THE lamp pump shown at work delivers 400 to 500 gallons per hour with a suction lift of 25ft. and against a head of 60ft., the cost of this service being stated as under 1d. per hour for fuel and oil. The power utilized is steam generated at about atmospheric pressure in a small boiler; the steam then passes through a vertical control valve to the under side of the piston.

The piston in the steam cylinder is raised by the pressure of the steam beneath it and the vacuum above it; when approaching the top of its stroke, a port, leading to the base of the valve casing, is uncovered by the piston, and the steam is admitted through this part of the control valve, being regulated by a dashpot at its base. The raising of the control valve cuts off the steam from the boiler and places the parts leading to the top and bottom of the steam cylinder in communication, and at the same time cuts off the free passage to the condenser. The top and bottom of the steam cylinder being in direct communication, the piston, piston rod, and pump plunger descend, the piston being in an equilibrium of pressure. The down stroke is effected by the pressure acting on the upper surface of the pump plunger, which has vacuum beneath it, and by gravity. The control valve is kept up by the steam admitted beneath it until the piston approaches the completion of its down stroke, when a port is opened by the piston rod, which permits the escape of the steam to the condenser from the cylinder, and beneath the control valve; the control valve then descends and admits steam to the under side of the piston, and at the same time opens a free passage from the upper portion of the cylinder to the condenser, and the action is repeated. To start the pump after steam has been raised it is only necessary to actuate the handle for a few strokes; this action pumps out any air, oil, and water from the condenser and establishes a partial vacuum therein, and at the same time admits steam to the cylinder; after a few strokes the actions are established for automatic continuance. The use of a "Primus" lamp burning ordinary lamp oil enables the steam to be generated in a very few minutes, and maintains a constant supply; an ingenious arrangement regulates the supply of water to the boiler to a constant level. Having only two moving parts, and these vertical, the wear and friction are reduced to a minimum, and there are neither piston rings nor packing leathers to wear out. The water being pumped is the condensing agent, and the exhaust water is used over and over again to generate steam, and is not in contact with the water pumped. Primarily this pump is intended for domestic supplies in country houses, farms, &c., but it can be easily adapted to pump other liquids besides water. The cost of the whole plant—boiler, lamp, pump, &c.—is very small (£35),

and, of course, the cost of fixing is trifling, as no foundations are required. The invention has occasioned a deal of attention amongst engineers generally. The makers who have turned out the pumps have put first-class work into them, and the pump shown in parts discloses a fine finish.

The Pulsometer Engineering Company, Ltd., Reading.

A special feature of this company's exhibit is a No. 12 Pulsometer steam pump. This is larger than any size before shown at an exhibition, in this case the capacity of the pump being 150,000 gallons per hour, and its height 126in.

Philip F. Oddie, London, S.W.

Several specimens of the Oddesse patent duplex steam pumps are shown in operation.

Reavell & Co., Ltd., Ipswich.

This company has an extensive exhibit, which includes several examples of their well-known compressors, and also a high-speed enclosed engine, suitable for driving electrical plant. The compressors shown are:—

(*a*) A single ended, two-stage, water jacketed, quadruplex air compressor, having a capacity of 260 cubic feet of free air per minute when running at a speed of 275r.p.m.; it is a belt-driven machine, complete with fast and loose pulleys and intercooler, and suitable for any working pressure up to 150lb. per square inch.

(*b*) A three-stage, single ended, high pressure, jacketed, quadruplex air compressor, having a free air capacity of 70 cubic feet per minute when running at a speed of 325r.p.m., suitable for any working pressure up to 1200lb. per square inch; complete with fast and loose pulleys, as used for high pressure work.

(*c*) A single ended, two-stage, water jacketed, quadruplex air compressor, having a free air capacity of 230 cubic feet, speed 315r.p.m., direct coupled to an electric motor of the General Electric Company's manufacture. The motor is of 45b h.p. capacity. The special feature about this machine is that the motor and compressor are direct coupled to each other, making a very compact plant, and so arranged that there are only two bearings to carry the whole of the rotating parts. It is the type of machine Messrs. Reavell offer for the supply of compressed air for pneumatic tools or for mining work. The machine is shown in operation at the exhibition supplying air to other exhibitors.

(*d*) A special duplex, unjacketed air compressor, as used for central station cleaning. The plant is mounted on rubber-tyred wheels, and is complete with draw-bar, driving motor, and gears; it is suitable for any working pressure up to 30lb. per square inch. This is one of the standard plants which the makers supply in large numbers for central station work.

The steam engine exhibited is one of the firm's 5 3D high speed, double-acting, enclosed type, suitable for dynamo driving or for fan driving, and capable of working at any pressure up to 140lb. per square inch, and of developing 14b.h.p. at this pressure. Normal speed, 600r p.m.

There is also shown an 8ft. by 5ft. lift, vertical hoist, on stand, capable of lifting 3500lb., supplied with air at 80lb. pressure.

The Warsop Petrol Rock Drill Syndicate, Ltd., Chorley.

Petrol is the motive power used for actuating this rock-boring machine, which is effected by transmitting the motion of a small electrically-fired petrol motor to a spindle, in which is fixed the drill bit for boring holes in the rock to be blasted.

The high speed of the motor and reciprocating drill spindle is eminently suited for drilling holes in a rapid manner, and the cost of drilling is also considerably reduced in proportion. The company state that they are also placing on the market batteries of these drills, actuated by one or more petrol motors at a short distance from the face of the rock to be operated upon.

Hand Tools and Appliances.

The Patent File and Tool Company, Ltd., London, E.C.

This company is exhibiting for the first time the "Dreadnought" patent milling file, which has only recently been brought out, and which, according to expert opinion, should practically revolutionize the file trade. A large up-to-date factory in London has been erected and fitted on an extensive scale with all the latest machinery and appliances for manufacturing this file. The teeth are semi-circular, cut on both sides, and a supporting back is used in conjunction

with the file which enables a mechanic to get a much better purchase over his work. It is also self-clearing, and can be four times recut when necessary at half the cost of re-cutting an ordinary file, and after each recutting is as good as new. The company hold some very flattering testimonials from well-known electric and engineering firms, and a visit to their stand is of great interest to engineers and others, where a practical proof of the above claims can be seen, as workmen are giving demonstrations with the file daily.

Crown Works, Chelmsford.

In this case the exhibit includes products of a special automatic surfacing process in the form of engineers' surface plates, straight-edges, tribars, vee-blocks, and parallel strips of cast iron. The special feature of these is their low price, the surfacing process used doing away with hand-scraping.

Fastnut, Ltd., London, E.C.

The "Fastnut" washer is a well-known device for holding nuts, studs, and screws under any vibration.

The "Fastnut" washer is shown on bolts holding bearings with half-inch play, and shafting running 1000revs.; the nuts can be moved with finger and thumb, yet fail to become loose through vibration. There is also on view at the stand a bolt which has half the nut and washer worn away through excessive use in a stone crusher; the nut is still immovable, though unsupported by anything except the "Fastnut." The "Fastnut" obviates the use of check nuts, drilling bolts and fitting castle nuts and split pins, &c., thus effecting a very great saving of time and money. It is reliable and prevents accidents. The Accident Insurance Company, Ltd., make a reduction of 5 per cent. on their premiums on all motor-cars fitted throughout with "Fastnut" washers. The makers make the offer that they will pay £10 to anyone showing them a nut that can get loose through vibration where the "Fastnut" washer is properly applied.

J. H. Heathman & Co., London, S.W.

This well-known firm exhibits a selection of its various manufactures, including patent combined steps and ladders; these are capable of being used either as a self-supporting step-ladder or as an extending ladder which can be adjusted at intermediate heights, or, again, they may be divided for use as two ladders separately.

Patent telescopic trestles; and telescopic ladder towers or portable scaffolds, which enable a person to get to places where otherwise he would have to erect scaffolding at a much greater cost, are noteworthy. There are also exhibited one of the "Derby" type wheeled ladders for fire-escape and other purposes. This ladder when being run along can be lowered down flat, thus affording the men a clear sight of the route, and having the additional advantage of storage in a much smaller place. The ladders can be adjusted at any angle from the truck for use where the truck cannot enter. Smaller fire-fighting appliances in the shape of London Fire Brigade hand pumps; "Pedestal" fire sets, comprising six fire buckets on a stand, a stirrup pump, and a hatchet all complete; fire hydrants, hose, rope ladders, &c., are also shown.

The Soho Metal and Scientific Instrument Works, London, W.

This firm exhibits a selection of scientific instruments, including range-finders. The "Owen" topometer is a distinct speciality as used for military, naval, and surveying purposes.

Engineering Processes and Materials.

E. A. Brandon & Co., London, E.C.

As agents of the London Sherardising Company, Ltd., Messrs. Brandon are exhibiting the galvanizing process recently developed by Mr. Sherard Cowper-Coles. The method adopted is unlike hot galvanizing inasmuch as the articles are placed in a closed vessel and packed with zinc dust, the whole being heated to a temperature considerably below the melting-point of zinc; the result is that the zinc dust is coated or furred on to the articles, either steel, iron, brass, or aluminium, forming an alloy with the metal. The coating is very difficult to strip and is perfectly rust-proof, even when a portion of the outer coating is removed. The coating is very smooth and even. Sherardized articles that have been previously buffed will take a very bright and lasting polish. The exhibits include builders' and contractors' ironmongery, also horse-bits and harness fittings, golf clubs, skates, carriage and trap fittings, chains, anchors, ship fittings, rolled embossed iron ornamental stampings, hand iron-

work, electric light fittings, conduits, tubes, gas and steam pipes, &c. There are also shown a number of interesting samples which have stood various tests.

The bolts, nuts, and screws have the advantage that they do not require tapping or the threads touched in any way, as in the case of hot galvanizing, the threads being perfectly smooth.

The Non-Explosive Gas Company, Ltd., London, S.W.

Specimens of Cox's air-gas plant as used for lighting and heating purposes are exhibited in operation.

The Northamption Direct-Castings Company, Ltd., Wellingborough.

This firm makes a speciality of castings run direct from the blast furnace. Their work includes tunnel segments for tube railways, tubbing plates, columns, tanks, &c., cylinders for bridges and wells, crane castings, wheel centres, crane beds, electric road tramway work, heavy and light engineering castings of every description to specification.

Thomas Butlin & Co., Ltd., Wellingborough,

exhibit specimens of foundry and forge pig iron, and also samples of blast furnace slag, &c.

The Bates and Peard Annealing Furnace Company, Liverpool.

A small type of Bates and Peard furnace, suitable for annealing jewellery, watch cases, and similar small articles, is shown in operation at this stall. The object of this furnace is to attain a perfectly bright annealing on all non-ferrous metals which come from the furnace free from scale or discoloration, and thus avoid the pickling, washing, &c., incidental to the old-fashioned methods of annealing. The furnace is provided with an automatic means of loading and unloading the metal into and from the annealing chamber, and by so doing effects a great saving of labour in handling.

It is found in practice that all non-ferrous metals are easily annealed by this process, coming out from the discharge water seal as clean and bright as they were put in, and having sufficient latent heat to thoroughly dry off the moisture without application of any further heat; thus there is no scale, no pickling in acid, and no washing or fixing.

The saving effected by this process on copper goods alone is equal to 10s. per ton of metal annealed, which figure has been ascertained as the result of an extended use of this furnace on a large scale. On more precious metals the saving is enormously increased.

W. H. Lilienfeld, London, E.C.

"Castolin" is the interesting speciality shown here. It is a new brazing material for cast-iron which, it is said, makes so good a joint that castings mended by it will not break a second time in the same place. This extraordinary claim of the inventors has been made good time after time in tests carried out by leading engineers in the United Kingdom. Like "Thermit," "Castolin" is no accidental discovery, but is the outcome of research and close study of the conditions of the problem. It is a scientific product which has been worked out in the laboratories of Messrs. Wassermann & Co., Lausanne, Switzerland, and is obtained from their established agencies throughout the United Kingdom. "Castolin" is not difficult to use and needs no special plant. It is rubbed into the pores of the broken surfaces, which have been previously cleaned with a wire brush, the pieces being joined together accurately with clamps and placed in a clear charcoal fire (assisted by gas blowpipe for large castings). When they have become hand-warm more of the "Castolin" is rubbed into the fracture. The line of fracture is covered with plenty of borax and "Castolot" Spelter, and the casting is replaced in the fire and brought up to a red heat until the "Castolot" Spelter runs freely with a bluish flame. The brazed casting after polishing is as good as new in appearance, and, as has been shown by repeated tests, the fracture will resist breakage better than the rest of the piece.

The Hoyt Metal Company of Great Britain, Ltd., London, E.C.

Specimens of Babbitt and other anti-friction metals, type metals, and various alloys of tin, lead, antimony, and copper form this company's exhibit.

Markt & Co., London, E.C.

Specimens of various sizes and grades of Pike Corundum wheels are on show.

Britannia Foundry Company, Coventry.

This firm show their patent moulding machine, also an improved enamelling stove, and some castings.

Machine Tools.

Henry Pels & Co., London, W.C.

THIS firm makes a speciality of shears and similar machines. The examples on the stand exhibit many noteworthy features. The general details of the machines are as follow: Joist shears capable of cutting joists up to 16in. by 6in., and equivalent sections in channels, angles, plates, &c. The machine is driven by an 11h.p. Westinghouse motor, the transmission being by Renolds chain.

A double-ended notching machine capable of cutting joists from 4in. by 1¾in. up to 16in. by 6in., or channels from 4in. by 1¾in. up to 15in. by 4in. This machine is driven by an 8h.p. motor.

Bar, angle, tee, and channel cropper capable of cropping without change of blades round bars up to 2¼in., square bars up to 2in., angles up to 5in. by 5in. by ½in., &c. This machine has a further cutter for cropping channels up to 6in. by 3in. by $\frac{5}{16}$in. by $\frac{7}{16}$in. A 2½h.p. motor on the top of the machine provides the driving power.

The next machine is a bar, angle, and tee bevel cropper capable of squaring angles up to 6in. by 6in. by ⅝in., &c.; and on a bevel at any angle from 45deg. to 40deg. right and left hand, angles up to 5in. by 5in. by ⅝in., tees up to 6in. by 4in. by ⅝in. The power is supplied by a 4½h.p. motor, also fitted on the top of the machine.

Another machine is the splitting shear driven by an 8h.p. motor, and capable of splitting plates of any length and width up to ⅜in. thickness.

Sanderson Bros. & Newbould, Sheffield.

The exhibit illustrates the adaptability of this firm's high-grade steels for all classes of work. They are specialists in the manufacture of steel for high-speed cutting of metals, magnet steel for electrical work, and high-tensile steels for motor-cars and cycle work. The qualities of some of the tool steels are exhibited on several machine tools at work, all of which are electrically driven, as follow:

A 10in. centre high-speed lathe, built by John Stirk & Sons, Ltd., Halifax. This lathe has an all-gear head, and has a wide range of speeds which can be operated with the lathe running.

A 30in. cold saw by Clifton & Waddell, Johnstone, near Glasgow. This machine is fitted up complete with one of the exhibitors' 30in. high-speed saws. The machine is fitted with a self-acting feed motion which is variable from ¼in. to 1½in. per minute.

A vertical drilling machine built by Tangyes, Ltd., fitted up complete with speeds and feeds to the requirements for testing the durability of the "SaBeN" high-speed drills. The spindle speeds are: with back gear 191–229, with single speed 351–428–522, with rate of feed per revolution 1/26, 1/46, 1/62. It is capable of boring a ¾in. hole in cast iron at the rate of 20in. per minute. The lathe is driven by a 35h.p. motor built by the Lancashire Dynamo and Motor Company, Ltd., Manchester. Drilling and sawing machines are driven by 9h.p. and 11h.p. motors respectively, built by the Union Electric Company, Ltd., London, S.E. The motors are all controlled by the Union "Fortiter" starters and regulators.

Arnold Schove, London, E.C.

Hack-saw Machines. — Hitherto the Americans have practically held the market for these, but the British-made machines here exhibited will prove themselves competitive in efficiency and price. They are fitted with a swivel slide which imparts to the blade a rocking motion, thus increasing the feed by about 25 per cent. without placing any extra or undue strain or wear on the saw itself.

Circular Cold Saw.—The 12in. diameter saw is a new departure, and where quantities of material have to be cut this machine would soon recoup its initial cost. It is quicker cutting than the ordinary hack-saw machine, although worked on a similar principle—gravity feed.

Universal Tool and Cutter Grinder.—This tool is essential in all shops where cutters are used, and the price is so low that there is no excuse for any works not grinding their own cutters and getting the most work out of them. The particular tool exhibited is claimed to be as accurate as any much more expensive tool, and the workmanship is of the best.

Twist Drill Grinders.—This is one of the most improved tools on the market. The index enables the grinding of drills to be done by a boy, for he cannot go wrong. The right clearance and angle can be easily and automatically fixed.

High-speed Sensitive Drilling Machine.—The price of this machine, £3 15s., seems incredible at first sight, but the workmanship

and materials are of the best. It is a British-made tool, and will drill up to ½in. diameter in steel.

Gear-cutter Lathe Attachment.—A smart tool for attaching to all-size lathes, thus giving works for a small outlay an efficient gear-cutter. Judging from the samples of work done, this tool will do much accurate and neat work. This tool is quite a feature of the exhibition.

"Trentum" Hack-saw Blades.—A good show of hack-saw blades is at this stand, and several details of times taken to cut mild and cast steel are given. The result of one test proved the "Trentum" 12in. blades in a Miller fall machine running at sixty-six strokes per minute to be quicker cutting than many other well-known blades; in particular it beat the perhaps two most used blades by 35sec. and 45sec. respectively when cutting 1in. cast steel. The times taken to cut six pieces off the same bar were 3min. and 7min. better when using "Trentum" blades.

High-speed Circular and Slitting Saws.—With the up-to-date tools now in use, and to meet the demand for quicker output, high-speed circular saws are coming into vogue in spite of their higher prices. They last a considerable time. In the case of slitting saws, the difference in price compared with the ordinary is very little, and it pays to use them even in the smallest of shops.

Showcase of Tool Steels, &c.—A splendid show of tool steels, files, &c., is made by Messrs. J. W. Schofield & Sons, Sheffield, for whom Mr. A. Schove is the sole representative in South-East England, and a large turning taken off a hammered bar at 46ft. per minute, cut ⅜in. deep by ⅛in., testifies to the quality of "Santanio" high-speed steel.

"Kosmoid" Time Recorders.—These recorders are claimed to have the recommendation that, besides being very reasonable in price, they have the additional advantage that they do not take up a large portion of a wall or require a special place apportioned off for them. The clock is guaranteed to keep correct time, and the whole working is so simple that there is no chance of anything getting out of order. The roll is long enough to take 2000 names and "times."

At this stand there are several other small tool specialities, such as vices, spanners, &c.

Cunliffe & Croom, Ltd., Manchester.

6ft. by 2ft. 6in. by 2ft. 6in. Planing Machine.—This machine is motor-driven, the drive being direct through a four-speed gear-box, the speeds of which are controlled by means of the lever only. The return speed of the table is constant, the cutting stroke only being variable. Open belts on both cutting and return pulleys. The machine is readily adaptable for belt drive by substituting a pulley on the gear-box in place of the electric motor.

Although not necessary when fitted with variable-speed drive, the patented belt drive is shown on the machine exhibited. This is an arrangement which enables the belt to drive at any angle between vertical and horizontal. This arrangement is only supplied with countershaft driven machines.

The movement of the table is controlled from either side of the machine. Ball thrust bearings are fitted to the elevation screws for raising the cross slide, and check nuts are provided in the tool box to take up wear and prevent lift in the tool slide.

Vertical Planer-type Milling Machine.—Although originally designed for milling aluminium gear-box and crank-case castings, as for motor-car practice, the machine exhibited may be suitably geared for milling cast iron and steel. The machine is direct driven by a constant speed motor, and is shown operating upon an aluminium crank-case, using a built-up cutter. The table has three rates of feed and is provided with auto-trip motion in both directions. For cross cutting the vertical spindle slide is provided with automatic feed and trip motions in both directions along the cross slides. This machine is also built with three heads, one on the cross slide and one on each upright.

Horizontal Milling Machine.—In this type of machine the table is self-acting in its transverse motion, with automatic trip. The feed motion to the table is obtained without the use of universal shafts, by means of bevel gear under the table. The spindle runs in gun-metal bearings, the front neck is coned and provided with antifriction washers to take the thrust. The back bearing is parallel with an external taper box providing adjustment for wear. The spindle is bored up Brown and Sharpe taper, a draw-in rod, passing through the spindle, holding the cutter mandrels in position.

Vertical Turning and Boring Mill.—The machine exhibited has a capacity of 30in. diameter by 14in. high. The table is driven by means of large spur wheels and pinion. The spindle is supported in a large gun-

metal bearing. The machine can be run either single or double geared. The turret slide has an automatic feed and stop motion both horizontal and vertical. The turret head is provided with locking and dividing motion, and is arranged for five tools. The universal chuck is 28in. diameter. A similar machine to the foregoing is also shown. This machine, which has a capacity of 20in. diameter by 11in. high, is similar in its general design, but has no swivel motion to the turret side.

Disc Grinding Machines.—These machines are designed for highly finishing flat surfaces on brass castings, forgings, and cast iron after machines. The steel discs, which are ground on the face to the limit of a thousandth of an inch, are spirally grooved on the face. This grooving affords a hold to the emery paper besides presenting a ribbed cutting edge to the work. Two tables are provided, one on each side of the machine. The right-hand table has a ledge raised above the surface, at right angles to the face of the wheel, acting as a guide for the work. This table is counterbalanced and swings on supporting shaft, enabling the work to be moved across the face of the grinding disc. The left-hand table is provided with a protractor, and will swivel to an angle of 45deg. to the face of the wheel. The table is also adjustable vertically to suit the angle required on the work. Screw pressers are provided for securing the emery papers to the steel discs. The two machines are similar in design, one of course having a larger capacity than the other.

Upright Drilling Machines—These machines are provided with self-acting down feed with auto-trip, hand feed by worm-wheel and rack, also sensitive feed by hand wheel acting directly on the rack-and-pinion shaft. The spindles are balanced and the sleeves are graduated for reading depths. The larger machine will drill up to 1½in., and will admit up to 24in. diameter by 2ft. 6in. under spindle nose to table. The smaller machine drills up to 1¼in. diameter, and admits 20in. diameter on table by 2ft. deep under spindle nose to table. The table swings aside on turned pillar, and is elevated by screw and bevel gear.

Portable Tool Tray and Vice.—For holding loose tools, finished parts, &c. It is made in various styles, either with or without vice, complete with drawer, with lock and key.

Ludw. Loewe & Co., Ltd., London, E.C.

A representative line of machine tools is shown, many in operation. The latter include a universal milling machine fitted with patent automatic indexing apparatus. This new attachment automatically operates the dividing head, and while effecting a great saving in labour, obviates all risk of wrong divisions being made.

A large vertical milling machine, which is especially adapted for milling pieces of irregular outline, such as gear-boxes, is shown machining the latter.

The advantages of the circular milling machine over the lathe for a certain class of work are practically demonstrated.

The Defries-Keyway cutting machine is unique inasmuch as it automatically mills keyways to the desired depth and length in one cut.

The Tindell-Albreght crankshaft lathe, by means of which over 65,000 crankshafts are turned annually, is shown in operation.

Special attention is directed to the 10in. by 50in. Norton cylindrical grinder, which gives practical demonstration of the modern tendency to rough-turn in the lathe and then grind to finished size.

Various Fontaine saw sharpeners and cutter grinders, which are entirely automatic in action and most efficient machines, are shown fulfilling their various purposes.

Among other machine tools exhibited at this stand may be mentioned the Loewe spur-gear cutting machine, turret lathe with chain-driven feed, pin and stud machine, drilling machine; also a Colburn vertical boring mill, and several types of Rumpf screw-cutting lathes, &c.

In addition to the foregoing, there is shown a fine selection of Loewe small tools, standard and limit gauges, also a large variety of micrometers, calipers, spirit levels, speed indicators, &c., and the English-made "Grip" keyless drill chuck.

Further, there is a representative range of the well-known D.W.M. ball-bearings, including a new type which is provided with a one-piece bronze cage for the balls in order to meet the wishes of those preferring a solid ball retainer. The Conrad plummer blocks and hangers are specially designed to take these bearings, and are used for the line shaft on the exhibition stand.

A number of portable electric drills, grinding attachments, and motors complete a most comprehensive exhibit.

Drummond Bros., Ltd., Ryde's Hill, Surrey.

This firm exhibits a complete line of small lathes specially designed for motor repairs. The lathes are fitted with a novel form of slide rest in the design of which is incorporated a large boring carriage. The loosening of one nut allows the upper slide to be entirely removed, leaving a truly-surfaced table fitted with ⊥ slots, converting the tool from a lathe to a regular boring machine for such motor-car work as cylinder re-boring, re-bushing gear-cases, &c.

These tools are also designed with the knowledge that in such work the lathe will be certain to be put on occasional jobs beyond its rated size, and they have been accordingly stiffened up throughout, and will stand up to work that would otherwise require a much larger machine: as an instance, the smallest lathe, a 3½in. centre, 2ft. 6in. gap bed, made for small running repairs such as touching up valve spindles, &c., will, in fact, take a ⅛in. cut on a disc of hard cast iron with the scale on of 9½in. diameter without chatter, or will reduce a steel shaft from 1⅛in. to ⅞in. in one cut. The sizes made are 3½in., 5in., and 6in. The latter has no gap as the others have, but is fitted with a new form of blocking pieces, which raise the centres to 9in. to get the necessary height for dealing with the diameters of crank-cases, gear-cases, &c.

In addition to these lathes, there is exhibited a small hand-lever bench-shaping machine, and also a very heavy 9in. centre, 9ft. gap-bed lathe, an extremely powerful tool designed for the use of high-speed steels in general manufacturing work. This tool is claimed to be probably the most powerful of its size yet made. It has a single pulley head-stock, pulley 12in. diameter, carrying a 5in. belt, the belt pull being taken on a separate sleeve clear of the mandrel running in its own bearings. This, with a two-speed countershaft, gives fourteen speeds, with two open-belt speeds of 100 and 200 and twelve speeds through six changes of back gear. Only the gears in actual use are engaged when back gear is in, and the lathe then is working just as the old-fashioned back-gear lathe would be, except that the back gears are totally enclosed and running in a bath of oil. The action of putting in or out the back gear automatically draws out or puts in the catch to the direct drive.

The bed is a gap one, but with the saddle slides formed on a level with, and extending the whole length of, the bottom of the gap. The saddle can therefore be worked right up to the head without any overhang of slides or tool, and no awkward gap-piece is necessary.

There are forty-four screw and feed changes, which are instantly available by moving a pair of levers without changing a gear, but this gear-box is so arranged that any metric or any odd or unusual screws can be cut by extra gear-wheels when required.

Reversing for screw cutting or feeding is done at the apron by a side lever always handy to the workman and so arranged that screws cannot be "crossed."

The tailstock is of new design, fitting the veed edges of the upper part of the bed, giving a truer lateral guide than the ordinary tongue and slot, as the action of fastening brings it hard to these guides as well as down to the flat surface.

The bed is of true enclosed box section, and is supported along the whole line of the gap by a box standard forming a cupboard. The cross braces inside the bed are diagonal in reverse directions, giving greater stiffness and resistance to the strains it is subject to than the usual vertical cross braces.

Wadkin & Co., Leicester.

These well-known specialists in wood-working machinery are showing their new mechanical wood-working machine, which for pattern-work purposes and general service possesses a unique advantage.

This machine is of a strong but graceful pattern with a powerful drive. Its unlimited range of usefulness arises from the spindle being carried (absolutely free from vibration) in the head of an overhanging arm. This arrangement allows of the cutter spindle working in any angular position between the vertical and horizontal. The cutter spindle, moreover, has a reversing motion, and is free to slide independently of any movement of the head, and is fitted with a positive quick-acting and also a slow screw adjustment.

The work supporting table is so mounted as to move freely with longitudinal and cross motions. It can also be raised and lowered, and will move through a complete circle horizontally. The turning of the table and swivelling of the head can be instantly effected, and the motion of the spindle can be reversed when working in any position.

Amongst other machines shown is a wood skiver which, being driven by power, will take a much larger cut than a hand machine, and leaves the operator with both hands free to feed and manipulate the work. The knives are of the usual kind, and automatically move to and fro the full range of the machine, but they can also be regulated to take a long or short cut from either fence as required, being actuated by a shaft continuously revolving in one direction.

A circular-saw bench shows good features of design, and is provided with an improved vertical adjustment of the table, which is conveniently and easily operated from one end of the machine and provides a perfect means for adjusting the height of the table. The saw spindle is of high-quality steel, and the bearings of phosphor bronze of good length and conveniently arranged for adjustment.

A corner lock jointing or square dovetail machine commands attention for the reason that it is not only of entirely new design and adapted for highly finished work, or the rough-and-ready packing-case, but principally from the fact that in direct opposition to the old-fashioned system of laboriously arranging and clamping down and cutting a number of pieces at one time, the work is fed singly to the cutters and is actually cut and finished as fast as it can be fed, and in much less time than it takes to put a number of pieces in position and clamp down ready for cutting in the old-fashioned way.

A vertical spindle moulder and shaping machine is also of good design, and should be seen to realise the many points of improvement.

Amongst other sundries is a quick-change vice, universally jointed in a manner that renders it convenient and applicable to an unlimited range of work.

A large variety of cutters, &c., and samples of work all combine to make a most interesting exhibit.

S. Wolf & Co., London, S.E.

This exhibit includes examples of modern high-speed portable power drills, and several types of electrical drilling machines are shown capable of drilling ¼in. to 4in. diameter holes in steel, and suitable for direct, single, and polyphase current working up to a pressure of 500 volts.

The "Featherweight" electric drills weigh up to 10lb. They are particularly suitable for such work as fixing name-plates, centring shafts, and for general drilling. Owing to the small current required this machine can be adapted to an ordinary electric-light pendant.

Other of these drills are for high-speed work in the softer metals, such as brass, copper, aluminium; there are several sizes taking up to ½in. holes. Another machine is the double-geared hand drill, arranged to give normal speed for standard makes of twist drills. There are also some three-speed hand drills; these are particularly useful for tapping purposes. Another adaptation of the light electric drill is the one driven by flexible shaft, a particular advantage of this being its suitability for drilling in confined spaces. Other electric drills are mounted on carriages. There is also an electric sensitive pillar drilling machine for bench work capable of drilling up to 2in. diameter in steel. A small drill grinder and other useful bench and hand grinders are shown.

Beanland, Perkin, & Co., Leeds.

This firm's exhibits include the Wilkinson patent steam temperature feed water heater, a new patent chain mortising machine, a stationary hack-saw, and also a portable rail hack-saw.

Chas. Churchill & Co., Ltd., London, E.C.

The selection of machine tools on this stand is of interest, not only as exemplifying the latest equipment at the command of the modern engineer, but also as illustrating the gradual evolution of the principal machine tools from the original idea embodied in the crude revolving spindle of the primitive lathe.

Two examples of the turning lathe are shown, one being a typical example of modern practice, and the other an antique specimen showing a comparatively early stage of the evolutionary process. This latter machine eloquently suggests the mechanical limitations by which our predecessors were handicapped, and for which due allowance is not always made when judging of their achievements.

The revolving spindle, equipped with a die to which the ends of rods could be applied in succession, is the primitive idea, modified and developed till we have the screwing machine, of which an excellent example is on view, fitted with a self-opening

die head of substantial and ingenious construction.

A more important modification of the lathe brings us to the turret machine, in which a bar passing through the hollow live spindle is operated on by a series of tools till the required part is completed and cut off, whereupon the bar is brought forward the necessary distance, and the cycle of operations is repeated. The Warner and Swasey hexagon turret lathe and the N. and W. combination are of this class. They both embody features which will appeal to practical men.

Still more specialized and complex developments of the same general idea bring us to the fully automatic machines, in which ingeniously combined cams assume the function of the operator, and enable the machines to perform their allotted tasks without constant individual attention and manipulation on the part of the attendant. In the "Simplex" machines (of which two are shown at work) four bars are operated on simultaneously, with a very largely increased output as the result. A two-spindle machine of the same make, which is specially adapted for the manufacture of nuts and similar pieces, is also exhibited. So much for the work from the bar. Another tool, the Potter and Johnston automatic chucking and turning machine, applies similar methods to the handling of castings and forgings, and has an ingenious arrangement by which both ends of the piece can be machined at the same time. In this way a second chucking is in many cases avoided, and greater accuracy as well as increased speed are secured.

Plain and universal grinding machines of latest design can also be seen, on which circular work (whether hard or soft) can be rapidly brought to correct size and desired finish. This is not only far cheaper than the old way of finishing rods and spindles in the lathe with file and polisher, but the results are so incomparably superior that grinding machines are in great demand, particularly in connection with motor-car parts and other exacting interchangeable work.

Gear-cutting machines are also much called for, and one is shown that has been expressly designed for the motor trade. It is the No. 0 Biernstzki gear generator, which cuts the gears by means of a hob, instead of employing a formed cutter in the ordinary way. It is very rapid in operation, produces theoretically accurate work, and a single hob will cut any required number of teeth correctly. The machine has a capacity for gears up to 16in. diameter by 12in. wide. For bevel gears another machine is provided in the form of the duplex-gear shaper, which works at a high speed and rapidly cuts the teeth to the required form. The machine works to the cone lines of the gear, and so produces a tooth which is exact in shape and proportions from end to end. The two sides of the gear are planed simultaneously, which, however, are both controlled by a single former. This ensures both sides of the tooth being precisely alike, reduces the cost of formers as compared with machines employing two separate cones, and allows any desired form of tooth to be produced.

The Cincinnati universal milling machine is so well known that description is here unnecessary; any who are not personally acquainted with this machine should make a special point of examining the specimen exhibited on this stand.

A Bickford radial drilling machine with gear-box drive is a good example of up-to-date design in its class, and the high capabilities and extreme convenience of this tool should be noted. A typical upright drilling machine of 22in. capacity, with principal driving and feed gears of cut steel, is also on view and will appeal to many.

Among minor matters of interest on this stand may be mentioned the following: A semi-automatic screw slotting machine; an admirable little machine for quickly forming the heads on rivets up to ⅜in. diameter by a noiseless spinning action; a useful wet emery tool grinder, with a gravity water supply and a highly efficient trueing device; the Norton "Alundum" grinding wheels, which are now well known and popular; and a selection of small tools and cutters of both carbon and high-speed steels. The exhibit contains abundant variety, and every visitor will be likely to find items of special attraction among so many of general value and interest.

Alfred Herbert, Ltd., Coventry.

The above firm show a very complete line of labour-saving tools in actual operation. Brief particulars of each are given below. The stand itself is a light structure composed of steel girders, the lineshaft being placed central and driven by a Lancashire Dynamo and Motor Company's

30h.p. motor, carried on top of the stand. The machines are arranged in two rows down each side of the stand, and are driven from above by countershaft.

No. 17 Combination Turret Lathe, with patent chasing saddle.—This machine, which is for dealing with heavy chucking work, is shown in operation machining bevel-gear blanks from mild-steel stampings. This machine is suitable for the most involved and difficult work up to 20in. diameter, and is provided with an exceptionally large spindle, which will allow 5½in. diameter bars to pass through it. The outfit of tools used in machining the bevel-gear blanks is interesting, as it consists of standard holders, which, with the addition of a small and inexpensive cutter, may be adapted for any ordinary work.

No. 6 Capstan Lathe, with patent chasing saddle.—This is a similar machine to the No. 17 combination turret lathe, but of smaller capacity. It is shown in operation machining spur-gear blanks from mild-steel stampings. The tools on this machine are also of a widely adaptable character.

No. 4 Capstan Lathe, with patent chasing saddle.—This represents the smallest size of lathe for chuck work, and is shown in operation machining a small commutator bush in cast iron. The special advantages of the patent chasing saddle are shown by chasing the external thread on the end of the commutator bush. The machine is fitted with the firm's patent single pulley headstock, which is driven by a constant-speed pulley, the different spindle speeds being all obtained by levers at the front of the headstock, and the machine being instantly stopped, started, and reversed by friction clutches.

No. 2 Patent Hexagon Turret Lathe.—This lathe is shown in operation producing bolts from mild-steel bar, using the firm's new patent roller steady-turning tool, which will be of great interest, as the application of the rollers has enabled the speed to be increased considerably. This machine is also fitted with the patent single pulley headstock, giving sixteen spindle speeds in either direction. This type of lathe is used solely for producing bolts, pins, studs, &c., from the bar, and is fitted with a very complete outfit of tools and accessories, which will handle all bar work within the capacity of the machine. The tools are so easily adjusted that it pays to make two or three articles only at each setting up. The "Coventry" patent self-opening diehead is used for screwing the bolts, and this is an interesting tool for the rapid production of accurate screw-threads.

No. 2 Full Automatic Screw Machine.—This is the medium size of the firm's well-known line of automatic screw machines, and admits bars up to 1½in. dia. It is shown in operation making a syphon lubricator body and cap from brass bar at one operation. The outfit of tools and the operations performed are exceptionally interesting, as the body is countercored, formed, tapped, and knurled; the shank is screwed, and the name is rolled on the outside; the cap is recessed, knurled, and screwed. Both these pieces are finished complete at one operation on a single spindle machine, and the job will well repay investigation as showing the capabilities of the automatic screw machine.

No. 8 Vertical Milling and Profiling Machine.—This is a heavy machine with exceptional capacity and ease of control. It is shown in operation face-milling with a high-speed inserted tooth milling cutter. The firm's patent dial feed motion is fitted, by which any desired feed is obtained by simply rotating a hand-wheel. All the movements of the machine are controlled by the operator without moving from the working position. The main dimensions of the machine are as follow: Automatic longitudinal feed to table, 62in.; automatic transverse feed to table, 38in.; maximum distance from spindle to table, 26in.; approximate net weight, complete, 15,000lb.

No. 1 Vertical Milling Machine.—This is a similiar machine to the No. 8 vertical milling machine described above, but of a smaller size. It is shown in operation facing up cast-iron blanks with a high-speed inserted tooth milling cutter.

No. 12 Horizontal Milling Machine, with patent dial feed motion.—This machine is shown in operation taking a heavy roughing cut with spiral cutter. The principal features of this machine are great strength and rigidity, combined with ease of control on the part of the operator.

No. 9 Horizontal Milling Machine, with patent dial feed motion.—This machine is very similar to the No. 12 size, but smaller.

Valve Grinding Machine.—This machine is shown in operation grinding the valve seats of small motors. This machine is capable of

doing three times the work of that performed by hand.

Nine-inch Centre High-speed Heavy Reduction Lathe, fitted with single pulley headstock.—This machine is shown in operation taking heavy cuts in mild steel. The special feature of this lathe is the patent bed, which enables the heaviest duty to be performed without destroying the ease of manipulation.

Newhall Universal Grinding Machine.—This is a new universal grinder having many valuable features which will be interesting to users. Special points are the variable-speed drive to the work table, and the ease with which the speed of the work can be changed.

Patent Gear Hobbing Machine.—This is a new machine for hobbing spur and spiral gears, and is of exceptional strength and rigidity. The patent feed motion by which the feed of the work table and hob saddle is controlled and changed, by simply moving levers on the side of the machine, is of interest. The machine is shown in operation hobbing four-pitch gears in cast iron.

Patent Worm-wheel Generating Machine.—This will be shown in operation generating worm-wheels by means of fly cutters, and is capable of generating worm-wheels of very quick lead. The advantages of being able to do this work by an inexpensive cutter will be appreciated.

Six-inch Cold Saw.—This is a particularly well-designed sawing machine driven by single pulley, and is shown in operation cutting blanks from mild-steel bars. The patent system of grinding the saw greatly increases the output of the machine. There is an automatic quick return to the saddle when the blank has been cut off.

Miscellaneous.

The Linolite Company, Westminster, S.W.

THE "Tubolite" system of electric lighting is a practically continuous straight line of incandescent carbon filament of the usual and well-tried type. The filament is contained in lengths of about 8½in. in straight glass tubes, ⅜in. in diameter, having one terminal at each end. The standard lamp is of 12c.p. The lamps are placed end to end in a semi-circular channel-shaped highly polished aluminium reflector, 2¼in. wide by 1in. deep, having an efficiency of 81 per cent. (compared with 92 per cent., the efficiency of highly polished silver). The two edges of the reflector are rolled into small beads, each of which carries one of the wires, which are thus protected from injury. The lamps are held firmly in the position for maximum efficiency in the reflector by aluminium and porcelain holders, having centre contact plungers.

"Dey" Time Registers, London, E.C.

Messrs. Howard Bros., the patentees and manufacturers of the well-known "Dey" time register, are again well to the front with a display of these machines. The "Dey" is a very ingenious machine for recording the times of the arrival and departure of employees by means of a weekly combined time and wage sheet, which gives the numbers of the employees in numerical order, with the whole of their "ingoings" and "outgoings" for the week on the line opposite their numbers, with extension columns for writing in the total number of hours worked, rate, amount of pay, &c., and can be arranged to suit any requirements and for any number of hands up to two hundred on one sheet. The machine is turned out in a manner creditable to the British firm who make it, and who guarantee its perfect working in every respect.

The machines are made in four sizes, viz., for 50, 100, 150, and 200 hands. Where more people are employed than can be taken on the largest machine, further machines are required. These are numbered to correspond with the number of the workpeople, or as recommended, placed departmentally according to circumstances, or as may be most advantageous to the employer.

The machine described above may be called the ordinary "Dey," and for cost-keeping, by means of an additional attachment, the time spent by employees on different jobs can be recorded on cards for the purpose of cost-keeping. This attachment does not in any way interfere with the ordinary time-keeping by weekly or daily sheets, but combines the two systems of time-keeping and cost-keeping, and is found extremely valuable where the actual times of the arrival and departure of workpeople must be recorded, and also the details of time spent on any particular piece of work.

At this stand may also be seen the automatic "Dey," which supplies the whole

week's time on one sheet as above, but moves automatically from one period to another at the proper times, which renders it unnecessary for the machine to require any attention whatever, except once a week to wind the clock and change the sheet, which may be done in two or three minutes. The great demand for this machine, not only for this country but abroad, shows the appreciation of the employers of labour for any time- and labour-saving machines that will reduce cost and ensure greater exactness.

A special feature of this interesting exhibit is the new autograph time recorder, on which the company have been experimenting for some time past, and which they have now got to a state of perfection and hope to be turning out for sale at a very early date now.

Jean Schmidt, London, W.C.

Oil and grease extracting machines are shown. These consist of a turbine separator, of which it is said there are over 2000 in operation throughout the world. There is also shown a special rotating washing machine, with automatic reversing gear, which is used for the purpose of further cleaning the waste, sponge cloths, or other material after the oil and grease have been extracted by means of the turbine separator.

A further exhibit is a new waste oil filter, the advantages of which are: extreme simplicity in construction, speed of working, and ease of access for cleaning. All of the above will be shown in operation.

Merritt & Co., London, E.C.

This firm are the well-known manufacturers of steel and expanded metal lockers, steel fittings, and manufacturers of adjustable steel shelving, suitable for engineering and electrical works. The expanded metal and sheet steel lockers are in use in nearly every large manufactory in America, and are now coming into general use in this country. Each locker is fitted with a different key, and a brass number plate is affixed to the locker numbered to correspond with the number on the key.

The patent adjustable steel shelving will readily appeal to all up-to-date firms, as it is far superior to the wood shelving, being much cleaner, saves a considerable waste of space, and is also practically fireproof.

Murray, Lotz & Co., London, E.C.

The particular exhibit consists of a model building erected on this company's Phœnix system of construction. This system has been specially designed to reduce the cost of wood construction, enabling buildings to be erected expeditiously, and at the same time providing a construction of strong and serviceable result.

Summerscales & Sons, Ltd., Keighley.

This well-known firm of laundry engineers are exhibiting three of their standard types of machines: Summerscales' patent "Peerless" shirt, collar and cuff ironing and finishing machine, with rolls 18in. wide, highly polished, heated on the duplex system of gas and air. All the gearing is machine-cut, the bearings are lined with anti-friction metal, the roller bearings are made to swivel, and fitted with an improved lubricating arrangement. The pressure between the table and the roller can be regulated to any degree by a spiral spring, the surface of the table always maintaining an equal pressure. This machine is fitted with a patent finger guard which reverses the machine as soon as the operator's finger comes in contact with the guard bar.

Summerscales' patent "Challenge Renown" washing, boiling, rinsing, and blueing machine, No. 2 size, capacity 120 shirts. This machine consists of an outer casing of galvanized mild steel, and an inner washing cylinder of perforated brass, 3ft. 3in. long by 2ft. 10in. diameter inside. The door opening is made the full width of the machine, and fitted with a galvanized wrought-iron sliding door and frame. The machine is fitted with an automatic reversing motion and locking gear for the inner cage; and also an improved patent arrangement for bringing the washing compartment into position for loading or unloading. The bearings are of the reversible gun-metal type.

The third machine exhibited is an ironing and finishing machine, with roller 96in. long by 18in. diameter, of cast iron, turned perfectly true, and mounted in a strong cast-iron frame, well stayed and perfectly rigid. The machine is geared at both ends, and the roller revolves in a cast-iron concave steam-heated bed, with a highly polished ironing surface. The roller can be easily raised and removed from the bed by means of power-raising gear. The pressure between the bed and the roller can be regulated to any degree, being controlled by spiral springs. An adjustable lip is provided in front for feeding, operated by a foot treadle

running the full length of the machine, and fitted with a patent automatic feed guard.

T. Demant, Newcastle-on-Tyne.

Here is a distinct novelty as an exhibit. Mr. T. Demant, as a technical and general translator of languages, makes a speciality of engineers' matters. At his stand are shown specimens of catalogues, price lists, specifications, contracts, &c., translated from and into English, French, German, Spanish, Portuguese, Italian, Danish, Norwegian, Swedish, Dutch, Russian, modern Greek, &c.

A. C. Cozens, Porth, Glamorgan.

An improvement in oil caps for axle journals and key for turning same, the rights for which are for sale.

D. Roche, Ealing,

exhibits written description and illustrations of three inventions as follow: Railway coupler, a railway brake, and a safety miner's oil lamp.

BOOKS RECEIVED.

Modern Mining Practice. EDITED BY GEORGE MITCHESON BAILES, M.E., M.I.M.E. VOL. 2. (SHEFFIELD: J. H. BENNETT & CO., 99, BROOMSPRING LANE TO BE COMPLETED IN 5 VOLS., PUBLISHED QUARTERLY. PRICE 10s. 6d. EACH NET.)

The engineer or student who has placed his order for this work will not be disappointed with the second volume. There is a point to which one might take exception: the book has neither a contents page nor index of any description. Doubtless this will be attended to properly in the last volume, but it would have been much better had some guide to the ground covered by each number been shown therein. So far as the matter itself is concerned, this is of the very best. The several chapters are devoted to: conducting the air to the working face, removal of gas, mine fires, self-contained breathing or rescue apparatus, first aid to the injured, diseases of miners, geology applied to mining, explosives and blasting, prospecting and boring. The book in its arrangement and nature of contents is more particularly suited to the requirements of the student of mining, although, of course, it will be found of benefit to all practical colliery men.

Practical Coal-Mining. EDITED BY W. S. BOULTON, B.SC., F.G.S. VOL. 2. (LONDON: THE GRESHAM PUBLISHING CO., 34, SOUTHAMPTON STREET, STRAND, W.C. TO BE COMPLETED IN 6 VOLS. PRICE 6s. EACH NET.)

The second volume of this noteworthy work fully maintains the high standard recorded in the review of Volume I. The branches of work dealt with include a further series of chapters on shaft-sinking: the various styles of tubbing and their cost, the handling of excavated material, dealing with water, pumps, winding water, ventilation, lighting, &c. Special methods of shaft-sinking are afterwards described at length. The fifth section of the work deals with the breaking of ground, and includes chapters on explosives, shot-firing, drilling machines, driving stone drifts, coal-cutting machines. Section 6 in this volume includes a chapter on methods of working and timbering. Throughout the subjects are handled at length, and supplemented by a numerous collection of illustrations, mostly line drawings to scale, which in themselves are bound to be of the greatest value to the mining engineer. Those electrical engineers who have to do with the power equipment of collieries, whether in the commercial or practical sense, will find this book pay for itself over and over again as a work of reference and as giving a simply written but thorough and reliable treatment of the ways and means of coal getting.

Guide to the Engineering Profession. BY W. GALLOWAY DUNCAN. (DUNDEE: JAMES P. MATHEW & CO., 77, COWGATE. PRICE 3s. NET.)

Die Montage elektrischer Licht- und Kraftanlagen. VON H. POHL. (HANNOVER: MAX JÄNECKE. PREIS M. 2.40.)

Die Krankheiten elektrischer Maschinen. VON ERNST SCHULZ. (HANNOVER: MAX JÄNECKE. PREIS M. 1.40.)

Prüfung elektrischer Maschinen und Transformatoren. VON FRIEDRICH WEICKERT. (HANNOVER: MAX JÄNECKE. PREIS M. 1.80.)

[*Owing to pressure on our space, we have been obliged to hold over the reviews of several important books. These will appear in the next issue.*]

COLONIAL CIRCULATION.—Next issue of THE ELECTRICAL MAGAZINE (Olympia Exhibition Number) will be specially circulated in the Colonies.

The World's ELECTRICAL LITERATURE

You should carefully study this page, as it will save you much valuable time. It is the key to the World's Monthly Electric Progress. We can supply the publications mentioned, or any article indexed, for a small fee. In writing us, enclose stamped P.C. for reply.

Power.

Three-phase Power Supply of the Manchester Corporation.	*Electrician*, 23/8/07.
Electricity in Factories and Workshops.	*Electrician*, 29/8/07.
The Electric Driving of Ring Spinning Machines. E. Bignami.	*Elec. Rev.*, 23/8/07.
Lightning Conductors. F. Broadbent.	*Elec. Rev.*, 23/8/07.
The Present Position of Gas and Petrol Engines. D. Clerk.	*Electrician*, 9/8/07.
Long-distance Transmission by Means of Direct Current.	*Elec. World*, 24/8/07.
Lightning Rods for High Chimneys.	*Elec. Wld.*, 3/8/07.
Electric Dumb-Waiter Machines and Systems. E. L. Dunn.	*Elec. World*, 3/8/07.
Isolated Plants. W. H. Stuart.	*Elec. World*, 3/8/07.
Electric Motors in Textile Factories. Cramer Chape.	*Elek. Zeit.*, 4/7/07.
Electric Driving of Spinning Machines. K. Schnetzler.	*Elek. Kraft u. Bahnen*, 4/7/07
Automatic Starting Switch for Induction Motors.	*Westn. Electn.*, 3/8/07.

Traction and Transport.

Storage Battery Traction. E. C. Zehme.	*Elek. Zeit.*, 8/8/07.
The Electrification of the Hammersmith and City Section of the Great Western Railway.	*Elec. Rev.*, 9/8/07.
Electric Traction on Railways. P. Dawson.	*Electrician*, 9/8/07.
The Use of Inter-poles on Railway Motors. C. Renshaw.	*Elec. Journal*, *Aug.* /07.
Single-phase *v.* Direct-current Railway Operation. M. MacLaren.	*Elec. Journal*, *Aug.* /07.
Swedish Railways. R. Dahlander.	*Elek. Kraft u. Bahnen*, 14/6/07
Electric Traction on Main Railways. P. N. Pfrorr.	*Elek. Kraft u. Bahnen*, 22/6/07
Inter-urban Traction Lines near Rome, Italy. A. de Courcy.	*West. Electn.*, 17/8/07.
Review of the Master Car-Builders' Brake-Shoe Tests.	*Str. Rly. Journal*, 3/8/07.
A Radical Design of Semi-steel Car.	*Str. Rly. Journal*, 10/8/07.

Central Station.

Cos Cob Power Station of the New York, New Haven and Hartford Railroad Co.	*Elec. Wld., N.Y.*, 31/8/07.
What is the best form of Power for Station of Five Hundred Kilowatts or Less?	*Elec. Wld., N.Y.*, 31/8/07.
The Stratford Power Station of the Great Eastern Railway.	*Electn.*, 12/7/07
Central Station Light, Heat and Power Principles. N. Harrison.	*Central Station*, *July*/07
The Financial Side of the Central Station. A. D. Williams, jun.	*Elec. World*, 3/8/07.
The Caffaro Electric Power Station.	*Engineering*, 9/8/07.

Lighting and Heating.

Luminous Arc Lamps from the Standpoint of Central Station Operation.	*Elec. Wld., N.Y.*, 31/8/07.
Spheretical Photometer. R. Ulbright.	*Elek. Zeit.*, 8/8/07.
The Mercury Vapour Lamp as a Factor in Electricity Supply Development.	*Elec. Rev.*, 23/8/07.
Government Incandescent Lamp Specifications.	*Elec. World*, 3/8/07.
Efficiency of Lamps. H. Lux.	*Zeit. f. Beleucht.*, 10, 20, 30/6/07
Glimpses of Street Lighting from Buffalo to San Francisco. H. T. Owens.	*Illumtg. Eng.*, *Aug.* /07.
Electric Lighting in Germany. P. G. Klingenberg.	*Westn. Electn.*, 17/8/07.
The Concepts and Terminology of Illuminating Engineering. C. H. Sharp.	*Elec. Rev., N.Y.*, 10/8/07.
The Specific Resistance and Temperature Coefficient of Tantalum.	*Elec. Rev., N.Y.*, 10/8/07.

Telegraphy and Telephony.

Radio-Telephony.	*Electn.*, 23/8/07.
Wire-Testing. L. M. Jones.	*Elec. Rev., N.Y.*, 24/8/07.
Hot-wire Relay for Selective Signalling. R. Heilbrum.	*Elec. Rev.*, 9/8/07.
Resistances in Telephone and Telegraph Practice.	*Westn. Electn.*, 17/8/07.

Design and Manufacturing.

Alternating-current Motors. H. Georges.	*Elek. Zeit.*, 1/8/07.
Electric Dynamometers for Testing Gasolene Engines.	*Elec. Wld., N.Y.*, 31/8/07.
The Cramp Single-phase Motor. W. Cramp.	*Elec. Rev.*, 9/8/07.
Hunting in Rotary Converters. H. G. Meade.	*Elec. World*, 3/8/07.

Students.

The Slide Rule as a Substitute for a Wire Table. O. E. Falch, jun.	*Elec. World*, 3/8/07.
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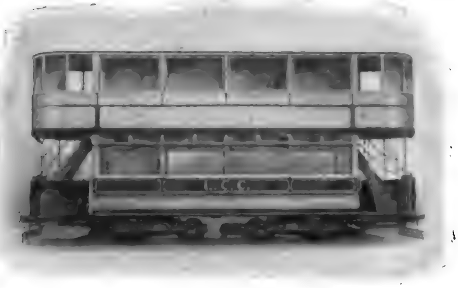

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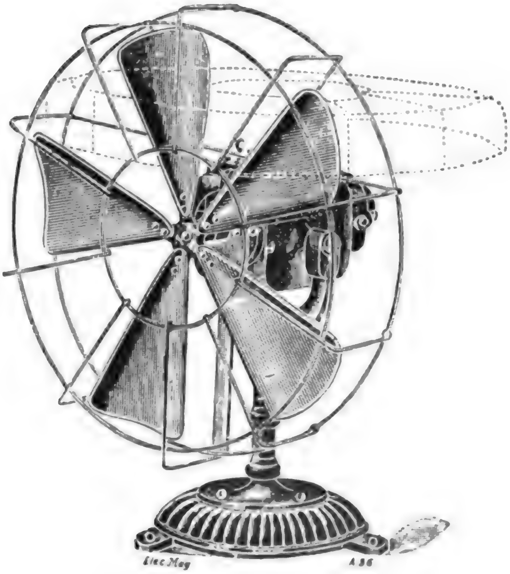

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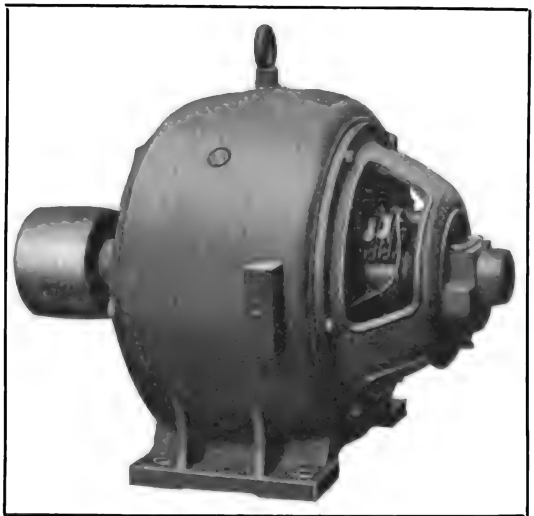

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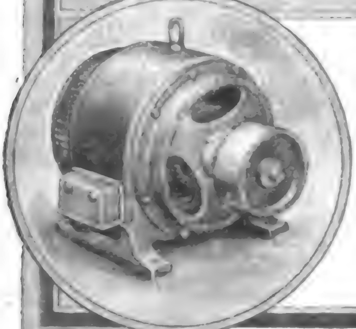

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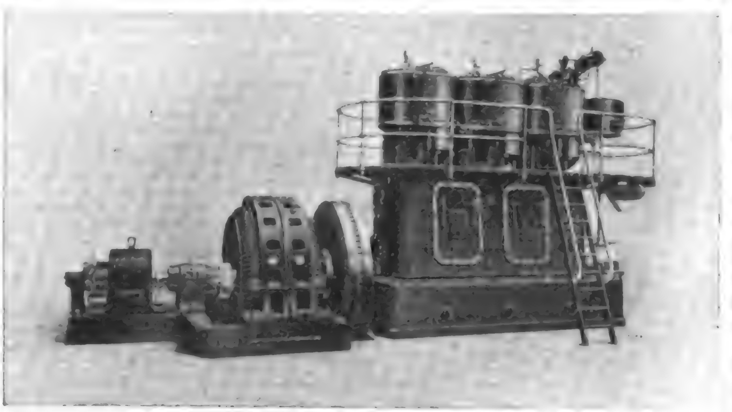

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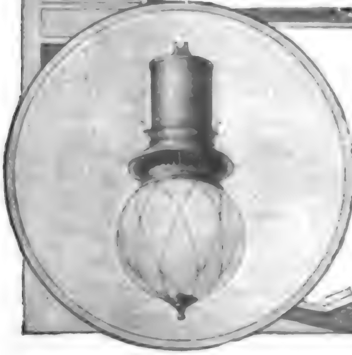

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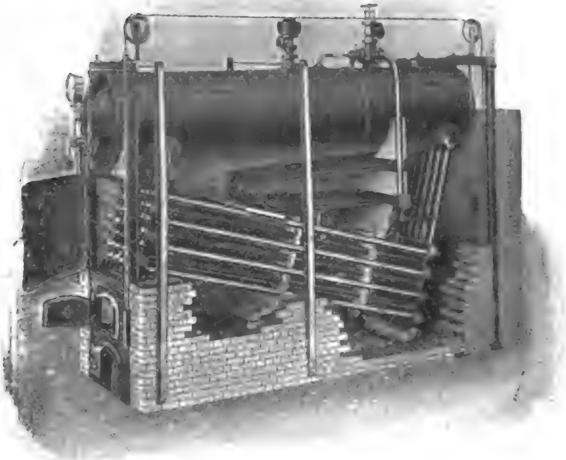

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The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

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The World's Electric Progress.

International Exhibitions.

IN this number, which is devoted very largely to a record of the recent Engineering and Machinery Exhibition, it is opportune to direct the reader's attention to a report just issued by a committee of the Board of Trade. In this report is urged the necessity for this country to enter thoroughly into international exhibitions, and although the British manufacturer may have some doubts as to the utility of such exhibitions it is pointed out that the country as a whole benefits. Amongst the reasons cited for the manufacturer standing aloof is one that exhibitions have been too frequent and that consequently they do not appeal as novelties nor are the prize awards of sufficient value. It is also said that advertising in other directions has increased very greatly and that the value of an advertisement of an exhibit is not compatible with its cost and trouble. Other complaints are that the average exhibition is too much the resort of pleasure seekers and makers interfering with business. It is, however, due to the lack of efficient organization that the causes for these complaints exist: the committee are convinced that British industries should be represented at world's exhibitions and that their neglect of this international advertising field is detrimental to this country's manufacturing interests. As said, the disappointment of exhibiting manufacturers in the past has been due to want of organization and definite plan of action; it is proposed that this shall be prevented in the future by the appointment of a permanent Board of Trade official to handle all the preliminary work and attend to the proper organization and arrangement of British exhibits.

Large Power Three-phase Pumping Plant.

THE description of the Lindal Moor Mines electric installation which appears in another part of this number will be read with interest by all electric power engineers and mining men. The most striking feature of the installation is the large size of the vertical centrifugal pumping sets which are arranged as for sinking purposes. The present duty is the unwatering of a number of mines which had been allowed to fill for reasons of the then condition of trade and breakdown of existing steam plant. With the mines in their present limited work there are some 750 men employed and the output is some 200 to 250 tons of iron ore per day: it is estimated that in the near future, now that the new electric plant has got under way, work will be found for about 1500 men and the output rise to 1000 to

1200 tons per working day. In selecting the nature of electric supply and the class of plant to be employed there can be no doubt as to the best system having been adopted. The three pairs of pumping sets are fitted with motors of outputs of 250b.h.p., 315b.h.p., and 750b.h.p. respectively; for motors of these large sizes and particularly where the duty is a constant steady service on load the supply of three-phase high-tension current direct to the motor windings is undoubtedly the most economical and best practice. It will be seen from the detailed description and illustrations which follow on pages 219 to 226 that the electrical control of the pumping sets is simplicity itself and that dangers of breakdown and personal risk are reduced to an absolute minimum. The starting and controlling gear of all the pumping sets is centred at the power station, where it is always under only skilled supervision; the only other switchgear in the high-tension circuits between the power house and each motor is in the substation on bank at each pit; here through an isolating switch the overhead transmission lines are coupled to the slip-rings of a cable winch or reel. The cable winch carries a coil of three-core high-tension rubber-insulated cables of a special flexibility by which the supply is led down the shaft direct into the pump motor.

Great electrical flexibility and mechanical flexibility have been combined in the entire installation. As the unwatering proceeds and the opposing lifts become greater, the pumps are so designed that they can be coupled in series, thus giving the normal full water output of each against double the head pressure of each set. Then again, pumps are arranged so that in the beginning of their service, when lifting against low heads, only a portion of the impellers are in use, the full number being brought into work as the sets are dropped lower down the shafts to their heavier duty.

The owners of the mines are constantly engaged in the exploration and proving of their district; so far this work has been attended with very gratifying results. It was consequently to their advantage to take up an electrical scheme which should be essentially pliant, which should permit of the individual pumping units being portable, suitable for operation in any position, and under a wide range of pressure heads and quantities. This they have secured.

As to the electrical end of the installation readers will note that it is throughout modelled on the best-proved practice as dictated by reliability and economy. In placing the work entirely in the hands of one firm of renowned success and wide practice in this class of work, the owners, Messrs. Harrison, Ainslie & Co., have been well advised; it is only where such installations are divided amongst a number of contractors of more or less inexperience that the element of risk—or as some term it experiment—enters.

The Lindal Moor Mine's plant is probably the most extensive of its kind yet put down in this country; there are many extensive iron-ore properties in the Cumberland district calling for similar treatment, and we may be sure that the steady success of this pioneer plant will occasion many enquiries from the district for large-sized electric pumping outfits in the near future. Electrical contractors will watch with interest the progress of this installation and will certainly bestir themselves in giving more attention to one of the richest mining districts of the country which has as yet only been a very moderate hunting ground for the electrical power engineer.

The Anglo-American Wireless Telegraph System.

The event of the month was undoubtedly that of Thursday the seventeenth instant, which day saw the culmination of the several years' labour of Mr. Marconi and the Marconi's Wireless Telegraph Company; on that day the British and American public were placed in possession of a regular wireless trans-Atlantic service. To the general public the most interesting feature of the innovation is that the charges for telegraph service are considerably less by

marconigram than by cablegram. It is here that one sees the power of competition introduced, but it is yet too early to venture any opinion as to the effect of the wireless system on the takings and business of the cable companies. In a lecture delivered at Olympia during the run of the recent Engineering and Machinery Exhibition, Mr. Charles Bright, F.R.S.E., expressed the opinion that the actual result of the commercial working of trans-Atlantic wireless telegraphy would be to give an impetus to long-distance telegraphy generally; that, as gas concerns prospered more after the introduction of electric light than before, owing to the demand for all-round better lighting—so will the cable companies gain by the entry of the wireless competing system, since further and cheaper facilities for Anglo-American communications will create an increase of business in telegraph dispatches all-round. We can well believe that this will be so; each new Atlantic liner and the course of current progress and events tend ever to draw Europe and America closer together, socially and commercially; the intercommunication of words of news, business, and greetings, must, when facilities exist, increase proportionally.

The Engineering Exhibition and the Press.

A CONSPICUOUS feature of the Engineering and Machinery Exhibition which closed at Olympia on the 19th was the number of high-class trade and industrial journals holding a fair proportion of the floor space. It is a sign of the times that what is probably our leading engineering weekly newspaper thought it well to be strongly in evidence. This is the first time we believe that our esteemed contemporary *Engineering* has seen fit to be represented at any Exhibition, and whilst admiring the spirit of enterprise evinced, we may be pardoned for the thought that perhaps the virility and up-to-date methods of the newer technical journalism of which THE ELECTRICAL MAGAZINE is an exponent has had something to do with the remodelling of the conservative attitude hitherto adopted by the older-established publications. We were glad to find ourselves in such good company, and gratified at the compliment indirectly paid.

We heard more than one complaint from exhibitors at the way in which they were approached by men responsible for the business departments of certain publications. We all want orders, whether we represent the advertising side of a technical publication or the commercial side of a motor firm, but there are methods—and methods. No one can truthfully gainsay the immense impetus that has been given to the trade by the forceful methods of the men responsible for the business departments of industrial publications. Introductions have been made, new connections have been formed, and successful results have followed the initiative of representative journals in this field. In regard particularly to the Exhibition just closed the enterprise displayed by the trade-press undoubtedly contributed very largely to the success of the undertaking. At the same time we strongly deprecate any methods of the commercial press man which wander from the strictly legitimate lines: an endeavour to secure cheap glory at the expense of the management of the exhibition, for instance, carries its own condemnation. When differences occurred between the managers of the exhibition and their official space agents, representing a prominent engineering paper, there was really no call for the latter to appeal to the sympathies of the exhibitors, and more important still, to utilise the sympathetic link to their own public aggrandisement and profit. Business differences are always regrettable, but not necessarily undignified. Had a little common sense and good judgment been exercised in this case we should not have had the unedifying spectacle of a technical journal canvassing the exhibitors and stall attendants to get up an entirely unnecessary agitation in the first place, and subsequently to try the merits of the collision

which ensued. Taking everything into consideration we believe that the exhibition managers did their work well, and that the interests of exhibitors had their closest consideration. It was one thing to get a big attendance at the exhibition of the general public, and another to secure the class interested in a practical sense. It was this latter class which the exhibition managers sought for and obtained without interference.

We have referred to this unpleasant matter because we feel that this sort of thing does not tend to enhance the reputations of the business departments of technical journals. If one prominent journal makes a *faux pas* it reflects in a manner upon the whole journalistic community, and it is not every man who has the time or inclination to discriminate.

At the inauguration and towards the close of an exhibition it is always pleasant and opportune to have some function of a friendly and social nature. The opening dinner given by the exhibition managers was conspicuous for its intelligence and all-round good-fellowship; unfortunately, the dinner at the close, which purported to be promoted by the *exhibitors*, was somewhat marred by the unfortunate personal friction mentioned above. Although the quarrel between the journal referred to and the management had been relegated to a back seat, and despite the fact that the management attended, there was a decided air of uncertainty and uneasiness. With perhaps one exception the speeches were uninteresting and to many even irritating by their length and tediousness. The speaker responsible for the press and whose *official* connection with the exhibition presumably accounted for his selection as spokesman—for there were many representative pressmen present—provided a little amusement and thereby somewhat relieved the monotony of the proceedings. He told those who remained of the company after the previous orations, that two outstanding things had struck him during the course of the exhibition (we could not help the passing thought that perhaps he had run his head against a Bridge or met the fist of a Smith); viz., the "ubiquity" and "self-effacement" of the press man. The former we can understand, but the latter! And it is beyond our imagination to reconcile in one being these two attributes.

There is one other matter as to the relations of the press and the exhibition which merits reference. We have to protest against the unfair competition which the promotors or managers of engineering columns or pages of the daily press level against the legitimate engineering journals who take and pay for space at an exhibition. Exhibitors were much canvassed, we are told, by representatives of such media, who had, strictly speaking, no *locus standi* at the exhibition. It is bad enough to have this form of competition at any time, but distinctly unfair under the special circumstances mentioned. It is further to be noted that those engineering firms who support the daily press by advertisements have only themselves to thank if they cast their bread upon a waste of waters not to come back.

Our readers will pardon this diversion in connection with an excellently organized and well-conducted exhibition. None of us were at the show disinterestedly; we as well as our contemporaries, however, can and should do our business in a manner worthy the highest traditions of the British press, and in no other way.

To Inventors and Patentees.

The Editor of The Electrical Magazine has made arrangements to submit any new idea, whether patented or otherwise, to a patent and commercial expert, who will give his opinion free of charge to readers of this journal as to the sale prospects, commercial value, and methods of securing a market. Correspondence solicited. Address Editor (Dept. F.), 4, Southampton Row, London, W.C.

The Electric Pumping Plant of the Lindal Moor Mines.

THE electric power installation which has just been completed for Messrs. Harrison, Ainslie & Co., Ltd., at their Lindal Moor Mines, can lay claim to particular attention on the part of engineers and the mining world generally, not only on account of the special features involved, but because it is the largest and most comprehensive plant of its kind yet put down in this country.

Before giving a general outline of the installation, it may be well to state generally the causes which have led up to the adoption of the present scheme. In some of the pits pumping operations ceased in December, 1903, owing to breakdowns, and through the pumping plant then existing being insufficient to cope with the inrush of water. The four pits so affected are connected together underground either artificially or by natural drainage. At the time the pumping operations ceased the maximum inrush of water reached nearly 7000 gallons per minute, though the normal dry-weather flow only amounted to about 4000 gallons per minute.

About 3300 gallons per minute was lifted out by the old pumping plant from two of the pits in question, one being the Lowfield Pit, 675ft. deep, and the other the Diamond Pit, 612ft. deep, an artificial connection existing between the two. A further 3300 gallons per minute was pumped out from the two Berkune Pits, one of which is 300ft. deep and the other 495ft. deep. For the reasons already given, and owing to the then existing business conditions, the pumping operations were abandoned in these four pits, until the matter came up again for serious reconsideration in the beginning of 1906.

In the four pits in question, viz., Lowfield, Diamond, and Berkune 1 and 2, three shafts were available for pumping plants, but the great initial difficulty to be overcome was the designing of plant which could be efficiently handled in the very small pump ways, and it was only after five or six schemes had been proposed and rejected that a satisfactory solution was arrived at.

Further, it was a very difficult matter to design plant of the required dimensions which would be capable of making any impression upon the inrush of water, and it was only the possibility of using electricity and high velocity pumps which induced Messrs. Harrison, Ainslie & Co. to seriously reconsider the project for pumping the mines dry.

The following are the dimensions of the pump shafts, which indicate the very small space which the pumping plants had to be designed to fit:

Lowfield—Two shafts, each 8ft. 4in. by 6ft. approximate, down to a depth of 378ft. from the top—below this depth, one shaft, 9ft. 6in. by 6ft. approximate.

Diamond Pit—Two shafts, each 6ft. by 6ft. approximate.

Berkune Pit—Two shafts, each 5ft. 3in. by 3ft. 5in. approximate.

A special arrangement of high-speed centrifugal pumps and direct-coupled motors was devised, and after mature consideration the following scheme was decided upon in April, 1906, and a contract for the complete plant was finally placed with The Electrical Company.

In each of the Lowfield Pits, which are inclined at an angle of 43deg., two centrifugal pumping sets have been provided, each capable of delivering 4000 gallons of water per minute against a total head, including friction, of 395ft. On reaching a depth of 378ft., where the two shafts join, these two pumps will be connected in series, and the design is such that when working in series they can together deliver the full quantity of 4000 gallons per minute against a total head of 780ft. One of these pumps is so designed that it can be eventually altered for duty as a permanent fixed pump to deliver 3000 gallons of water per minute against a manometric head of 525ft. The other pump is designed so that it can also work as a fixed pump, when it will deal with 2100 gallons against a manometric head of 700ft.

These two pumps are of the one-stage type, each having high-grade cast-iron case, impellers and guide wheels of special bronze, and shafts of special steel. They have planed feet for resting upon a special carriage, which is constructed of structural iron, and

running on rails having a gauge of 6ft. 6in. The pumps each have two wrought-iron delivery pipes, which are connected at the top by means of a Y pipe, which supports a rising main, 14in. diameter. The check valve has an internal diameter of 375mm., and the foot valve, 450mm. internal diameter, fitted with strainer. Each pump has a rope sheave, 4ft. diameter, mounted on suitable brackets. Each of the motors direct-coupled to these two pumps is capable of a continuous output of 750b.h.p. when working on a circuit of 3000 volts, 50 cycles per second, and the speed of the combined sets is 1485r.p.m.

In the two Diamond Shafts two vertical sinking pumps are provided, each of which is capable of raising 1000 gallons of water per minute against a total head, including suction, delivery, and pipe resistance, of 680ft. These pumps are also fitted with direct-coupled motors, having an output of 315h.p. at 1480r.p.m. The pumps are of the three-stage type, and in this case they are fitted with self-acting oil lubrication, elastic couplings, and cast-iron intermediate piece for connecting and centering the pumps with the motors. A breeches pipe is provided in each case, with wrought-iron suction pipe, 250mm. internal diameter, foot valve, and strainer; also two wrought-iron delivery pipes, connected at the top by a Y pipe, which supports the rising main. Each set is complete, with check valve, bye-pass, and gate valve, 225mm. diameter. Each pumping set is entirely enclosed in a framing of structural iron, and a suitable rope sheave is provided for carrying the weight of the entire pump with its motor, together with the electric cable and wrought-iron delivery pipe of 200mm. diameter, when filled with water under normal working conditions. On the side of each set is a service ladder, with wooden platform at the top and bottom.

In the two Berkune Pits are provided two pumping plants, similarly designed to those in the Diamond Shaft, but in this case each pump is designed for delivering 1000 gallons of water per minute against a total head of 540ft., the motors having an output of 250h.p., and the speed of each set being 250r.p.m. These pumps are each of the five-stage type. The arrangement of valves and pipes is the same as for the Diamond pumps. The suction pipe is 250mm. diameter, and the delivery pipe 200mm.

Each of the pumping sets has a complete set of accessories, including pressure gauge, air and drain cocks, filling funnel, and ejector for exhausting the air from the pumps, gate valves with the required pipe connections, and all the necessary spanners. The steel cables by which means the pumps are lowered into the pits are fastened at the pit heads, from which point they go down their respective shafts, round the rope sheave of each pump, and up again to the top of the shafts, where they are wound round the barrels of the winches provided for the purpose of raising and lowering. The delivery pipes for the vertical pumps are stayed in position by means of the steel wire ropes which pass up and down either side, stay rods being provided at various points with suitable guides through which the cables pass.

The weight of each of the Lowfield pumps, complete with its motor, suction and delivery pipe, suspension cable, electric cable, and its own column of water is about 75 tons.

With a view to affording rapid sinking operations, the Diamond and Berkune pumps have been specially designed so that during the first half of the operations of draining only some of their impellers will be in use. By this means the pumps will initially raise nearly 200 per cent. of their normal output, and when the half-way stages are reached the full number of impellers will be brought into action.

From the above it will be seen that the total initial quantity of water with which the whole plant will be able to deal is about 15,000 gallons per minute, this being reduced to 8000 gallons per minute as the pumps reach the lower levels.

The centrifugal pumps have all been provided and built by Messrs. Sulzer Bros., of Winterthur, who have had unique experience in the building of high lift centrifugal pumps for heavy duty. The motors are of very special design for working under the abnormal conditions, and are constructed with particularly narrow dimensions to admit of their passing down the narrow pumping ways available. They are all fitted with short-circuited rotors, and the motor cases are arranged with ample ventilation, and a forced circulation of air is maintained by means of fans fitted on the motor shafts. Although the motors are of the ventilated enclosed type, there is ample protection by means of suitable hoods against falling water or fragments, &c. A special feature is that

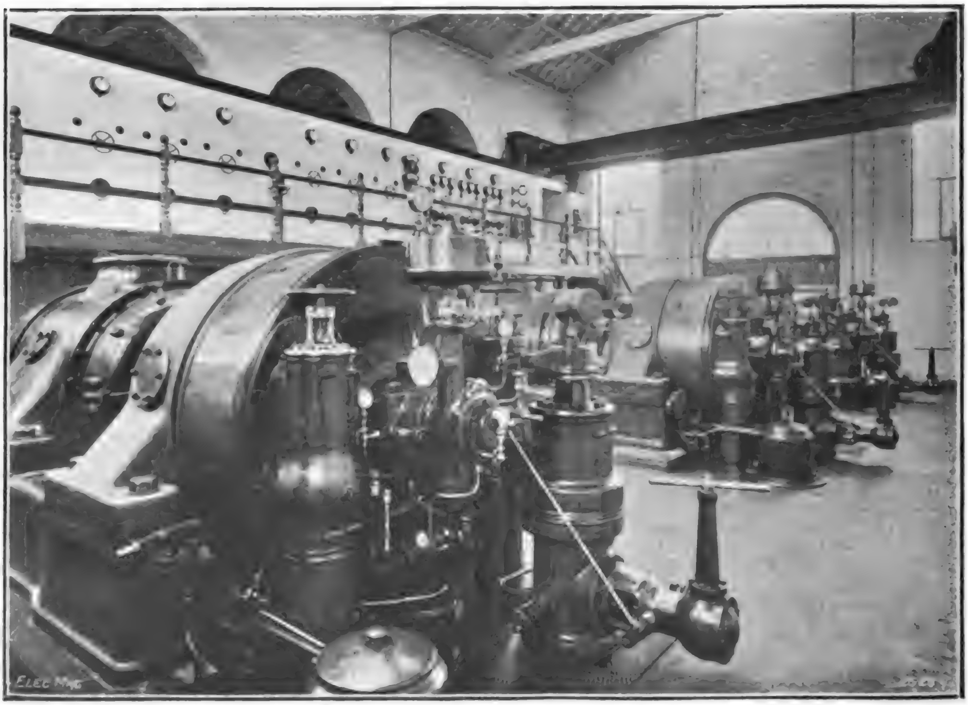
General View of one of the Lowfield Pit Pumping Sets.

the high-tension current of 3000 volts is taken directly to the motors without intervening transformers, all terminals and live parts being securely protected in such a manner that there is absolutely no risk of danger to the men in charge. The combined efficiencies of the pumping sets are: Lowfield, 73 per cent.; Diamond, 67.75 per cent.; Berkune, 72 per cent.

In order to provide power a central generating station has been built on a suitable site a short distance from Lindal Station on the Furness Railway, where there is a sufficient supply of water for condensing purposes. The distance from the power-house to the three pits is: to Lowfield, 980yd.; to Berkune, 800yd.; to Diamond, 1720yd.

A three-phase alternating-current system has been adopted, and in order to transmit the required power without undue loss and at the same time have a working pressure which could be used direct in the motors without transformers, a pressure of 3300 volts with a periodicity of 50 cycles per second was selected. The current is generated by three steam turbo-generators of the horizontal type, designed and constructed on the A.E.G. principle, each set being capable of a continuous output of 1140 electrical horse-power, 3300 volts, 50 cycles per second when running at 3000 r.p.m., and supplied with steam having a pressure of 200lb. per square inch at the stop valve and superheated to a temperature of about 600deg. F. Each turbine exhausts into a surface condenser of Messrs. Worthington's manufacture, specially designed for maintaining the high vacuum which is necessary for the efficient working of turbine plant.

The electric generator of each set is of particularly solid and staple construction, the rotating field possessing the characteristic of a solid cylinder. By a special system of ventilation and by water circulation in a double casing round the generator carcase and bearings, the entire generator is kept particularly cool. The turbine also runs practically noiselessly owing to the construction of the stator, which does away with the disagreeable noise or shrieking often set up by the ventilating discs existing in other types of plant.



Interior of Power-house, showing the Three 1140E.H.P. Turbo-alternators

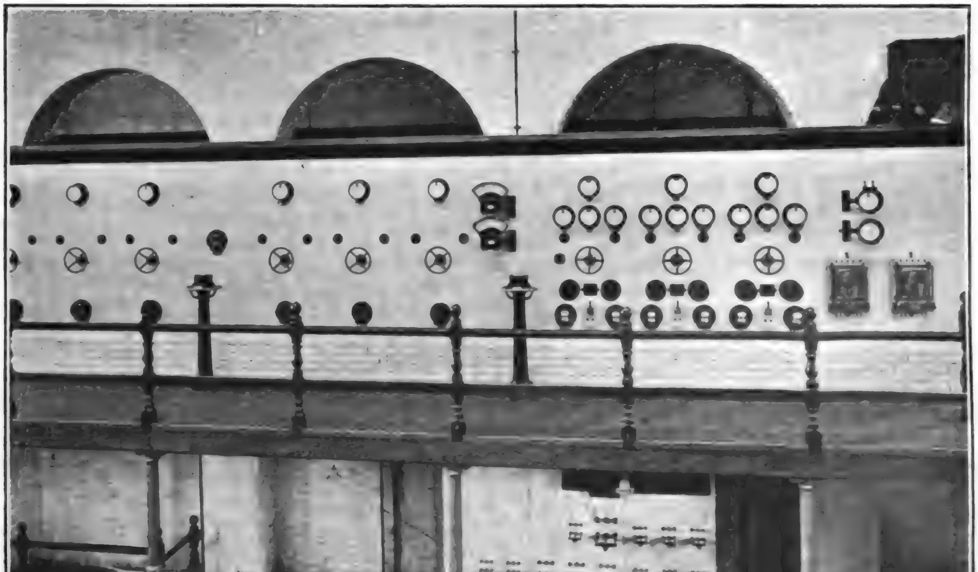
Each turbo-generator has its own exciter direct coupled to the main shaft, and by means of the "Tirrill" system of regulation, which automatically adjusts the excitation, the terminal voltage on the generator is kept absolutely constant irrespective of load fluctuations.

The steam range was erected by Messrs. Babcock & Wilcox; it is of a simple design and so arranged that each boiler and each turbine can be separately cut off. A steam separator is built into the steam range adjacent to each turbine. These separators are of the A.E.G. type and are built to meet the special requirements pertaining to turbine installations, the design being such that they absolutely prevent any grit or fine boiler scaling passing from the steam range into the turbine nozzles.

The boiler plant consists of three Babcock & Wilcox water-tube boilers, each having 4020 square feet heating surface, and arranged in one and a half batteries. Each boiler is capable of evaporating, under the most efficient conditions, 15,000lb. of water per hour. The boilers are fitted with superheaters each having 880 square feet heating surface, and capable of imparting 200deg. F. superheat to the steam produced. The boilers are provided with mechanical chain-grate stokers of the Babcock & Wilcox pattern, having a grate area of 74.7 square feet, the three stokers being driven from one shaft by a small three-phase motor.

The steam consumption of the generating plant obtained on test was about 15½lb. per kw.-hour, with a vacuum of 95 per cent. and steam at a pressure of 200lb. per square inch, and at a temperature of 572deg. F. This figure compares very favourably with the guaranteed figure given by the contractors of 18.2lb. per kw.-hour.

The current from the turbo-generators and to the motors is controlled by means of a main switchboard of cellular design—one of the first boards of this type to be erected in this country. There is no marble whatever in the construction of the board; the front is constructed of tiled masonry upon which the instruments are mounted, the switches, &c., being operated by means of handwheels. The connections are made to the switchgear by means of spindles passing through the tiled wall, these driving either direct on to the switchgear or by sprocket wheels and chains. This arrangement ensures the



General View of the Switchboard and Gallery.

isolation of the high-tension apparatus, and effectually minimises fire risks and personal danger.

A special feature of the plant is that each of the six pump-motors is individually under the control of the power-house engineer, the whole of the starting and stopping operations being carried out by means of the main switchboard apparatus. Two sets of busbars are provided behind the switchboard, one set for running the motors under full pressure, and the other for gradually raising the pressure at starting. The starting is effected by means of two transformers connected in series: one of these is an auto-transformer which reduces the voltage to about half the full working pressure, the second transformer has its primary connected in series with the auto-transformer and its secondary connected to the liquid resistance, which is gradually short-circuited on starting the motors. By this means the pressure on the motors is increased gradually and all large current rushes which might in the ordinary way affect the voltage regulation of the station are avoided. As soon as the motors have been run up to full speed on the auxiliary busbars, they are switched on to the main bars by means of change-over switches of the oil-break pattern.

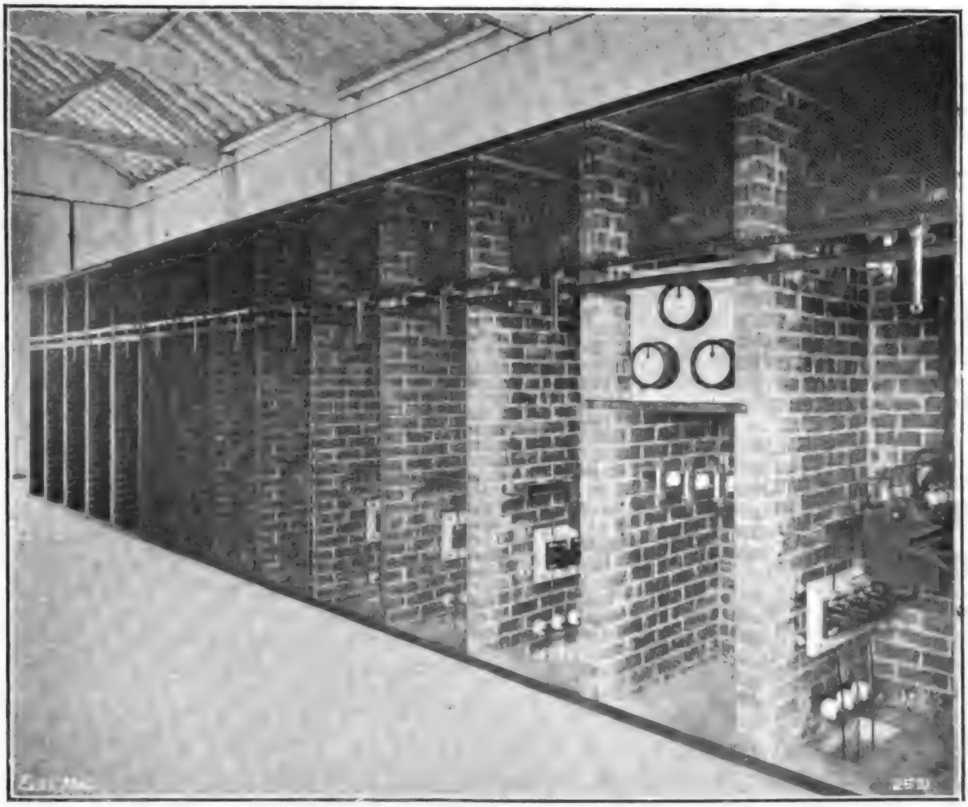
To protect the motors against overload, each line is provided with automatic maximum - current circuit - breakers. The handwheels operating the oil switches are connected thereto by means of trip gear, this trip gear being operated by solenoids which are fed with current direct from the busbars. The circuit-breakers are controlled by relays which are fed through special current transformers from the mains, and as soon as the current exceeds a maximum value the relay closes the solenoid circuit on the oil switch. This solenoid releases the switch from the handwheel and the switch is thrown open by means of powerful springs. The controlling relays can be set to act on various overloads according to wish, and can either be fitted for instantaneous operation, or with a time element which will only allow them to act after an overload has been on for some predetermined time. The arrangement of switching and controlling gear, it will be seen, dispenses with a considerable skilled staff which would otherwise be required. In this case the whole of the operations of the plant are directly under the entire control of the engineer in charge of the station, the only apparatus at the pit heads consisting of an isolating switch in each case, with a voltmeter to indicate when the current is on or off. On each motor in a convenient position is fixed an ammeter enclosed in a special water-tight case.

View of Switchboard from the Gallery.

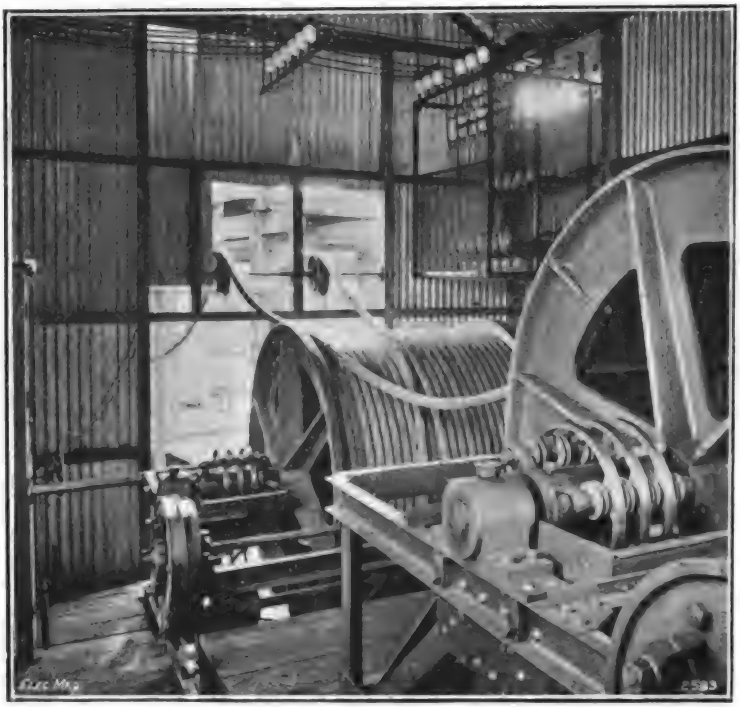
To permit of each motor being controlled from the power-house, a separate transmission line constructed of bare copper is run from the generating station to each motor, these cables being suitably carried on triple-shed high-tension porcelain insulators tested to 10,000 volts which are fitted on channel-iron cross arms erected on wooden poles. Where six wires only require to be carried one wooden pole is provided, but in every other case the line is carried upon double poles set in pairs about 8ft. apart.

The cross sections of the transmission lines are: to the Lowfield Pit, 50 square mm. per phase; to Berkune and Diamond Pits, 25 square mm. per phase. At the point where each transmission line terminates at the pit-head sub-station, the bare copper cables are connected to high-tension vulcanised rubber cables through a junction box mounted on the transmission line pole. The high-tension cables are in their turn connected through the isolating switch and through collecting brushes to the slip-ring of a specially devised cable drum.

The cables which carry the high-tension current down the pits to the motors are of special flexible pattern for transmitting the required full power continuously. The cables are of three-core stranded type insulated with pure and vulcanised rubber, the rubber being specially selected so as to render the cables entirely safe for a constant working voltage of 3000 volts between phases. The three-core cable for each motor is wound on its respective cable drum, one end being connected to the slip-rings on its shaft, the other end being connected through a watertight junction box fitted on the side of the motor direct to the motor terminals. By means of this arrangement the cable is paid out as the motor is lowered down the pit, and the whole of the live cables and terminals are effectually



Rear View of the Main Switchboard, showing the Cubicle arrangement of High-tension Switchgear.



INTERIOR OF THE LOWFIELD SUB-STATION, SHOWING THE SWITCHGEAR AND CONDUCTOR CABLE WINCHES.

sealed and protected mechanically and electrically. The isolating switches referred to above, which are fitted at the pit-heads, are further arranged with mechanical devices by means of which the men in the pits in charge of the pumps can in case of emergency immediately disconnect the motors from the mains.

A complete telephonic system has been installed between the power house and the various pits, by means of which the necessary communications can pass rapidly between the engineer in the power house and his staff at their various stations.

The whole of the contract, which from the boilers to the pumps has been in the hands of The Electrical Company, Ltd., has been carried out under the supervision of Mr. Henry Ward, M.I.C.E., 110, Cannon Street, London, E.C., consulting engineer to Messrs. Harrison, Ainslie & Co., Ltd.

The Education of the Engineer.

At a meeting of the Post Office Institution of Electrical Engineers held at St. Bride's Institute on Monday evening, October 14, Major O'Meara, C.M.G., the president, delivered the inaugural address. Whilst the paper was naturally framed to suit more particularly the telegraph and telephone branches of electrical engineering, the principles set forth were of sterling value to all engineers, and the following brief abstract has been prepared to bring into prominence the great truths expressed in an altogether admirable address.

No subject, probably, has been more discussed in engineering circles within recent times than that relating to the technical education of engineers and artizans. Many eminent men connected with the engineering profession have dwelt upon this question in their addresses, and have given expression to views which are well worthy our serious consideration. The subject is one of immense importance to us, affecting as it does the success of all our operations. Money can purchase the best of material, but to employ it to the greatest advantage requires that we shall have at our command well-educated officers to direct highly-trained workmen. What is it that the professional education of our engineers should aim at?

"'Tis education forms the common mind,
Just as the twig is bent, the tree's inclined."

The minds of engineers should be so formed by their professional education and

training that in later years, no matter what the nature of the task presented to them for execution in the ordinary course of their duties, still they should be able to pick out intuitively the principal features of the problem before them, and if any of these are new to them, they should be in a position to obtain, by a process of accurate reasoning, a solution of these novel aspects.

If courses of instruction are properly designed to develop the student's mental equipment on the lines indicated, then such as have been attentive and industrious in connection with their theoretical studies, and in addition have been observant when engaged on practical work, cannot fail to rise to the occasion when the demand is made on them.

If the author were asked what is required for success, he would unhesitatingly reply that according to his own experience the following is the order of importance of the qualifications which make for success:

(*a*) Personal equation;
(*b*) Commercial aptitude, or its equivalent administrative ability;
(*c*) Quality and extent of professional knowledge.

Many elements go to make up the personal equation of an individual. To enumerate but a few of the important ones: Initiative, mental capacity, industry, trustworthiness, resourcefulness, tact, judgment, perseverance, loyalty and good address. Some of these qualities are no doubt a gift of nature, but when they are not so provided they often can be acquired, to some extent by cultivation. They are by no means all of equal importance, nor are they always of the same relative importance and value in every case. Rather does the rank and position of an officer determine the relative value of each of these qualities in any particular case. There is one element in the personal equation not mentioned so far, but a reference to which ought not to be omitted; that is, the power of an individual to solve the personal equations of his subordinates. This instinct is certainly required in some degree by all officers in responsible positions, and in the higher ranks the possession of it is absolutely indispensable.

The second of the main considerations mentioned was commercial aptitude. This qualification requires in its possessor the power to control the organization under him in a manner to ensure that all the resources of men and material at his command are employed in turning out work at high efficiency and the most reasonable cost. To achieve this end, waste in all its forms must be checked, and running costs must be strictly controlled.

The position of the third of the main considerations affecting success must not be taken to imply a depreciation of the value of knowledge. The advance in engineering knowledge continues steadily and rapidly, and the real difficulty which exists is that connected with the apportionment of a student's time, so that it shall be devoted in a satisfactory proportion to each of the various subjects affecting his profession, in accordance with their relative value in his work.

The importance of including subjects of a commercial as apart from a purely engineering character in the education of an engineer is now becoming very generally recognised, and the author directed attention to the following reference to this matter quoted from an address given in America by President Humphreys of the Stevens Institute, whose words were:—

> "I contend that every engineer student should have some instruction in the principles of accounting, in depreciation, business law, patent law, banking, specification, and even sociology. And in connection with the business side of their training they should be made to see the importance of the correct use of language."

There are many pitfalls for the inexperienced man engaged in business, and it is necessary for every man to have some knowledge of the various ordinary legal points met with in business, in order that illegal acts may not be committed inadvertently. And further, when difficult questions arise, such knowledge will often indicate whether it is worth while to seek legal assistance in dealing with the matters involved. Again, at times, financial crises and questions bearing on the money market are likely to indirectly affect one's interests, and as problems connected with such matters are studied in connection with banking, a knowledge of this subject will not come amiss. Further, officers who rise to high positions are often called upon to frame

regulations for the administration of the branch under their control. It is perhaps on such occasions that the fullest advantage is derived from the knowledge of commercial law and many other business subjects. The value of a knowledge of depreciation, patent law and specification is self-evident. Officers who wish their administrative efforts to be successful will keep in touch with the aspirations of the various classes of workers, and further, will study the problems connected with the science of human society.

THE ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

THE 19th inst. saw the termination of the Engineering and Machinery Exhibition. The general opinion is that it was a great success; during the entire month of its duration Olympia was the rendezvous of all grades of engineers from every part of the country, and not a few from abroad. The general public attended the exhibition in large numbers, and on many evenings the great hall was filled almost to overflowing. The mysteries of moving machinery have always proved attractive to the layman; there is some glamour about the whirr of wheels and the screech of severed metal which appeals with force to everyone.

Many of the leading public men of the country were seen from time to time taking keen interest in the exhibits, doubtless many of them making comparisons of the new and vast array of special machine tools with the drill, lathe, and grindstone which served all machine purposes in the old-type mechanic's shop. It was in a very comparing frame of mind that the writer found the worthy President of the Local Government Board one day when passing through the exhibition. Mr. Burns not only criticised this country's work with reference to Continental competition, but expressed many interesting opinions as to the respective value of the engineering worker of London and the provinces. It will doubtless please the London mechanic to hear that he has a staunch supporter in Mr. Burns; as to the North Countryman—he must come to London to do his best work.

Our Continental engineering rivals were in force both as exhibitors and visitors. Noticeable also were the wise children of the Far East; enter the Exhibition when one would, there were always some of the Mikado's subjects to be seen. Ever keen and enquiring, these diminutive engineers were conspicuous by their very intentness, each one quietly and without ostentation performing his part in the making of a world's great nation. At least, so it seemed to us, and, indeed, whenever and wherever one meets a Japanese he seems to be absorption personified; he is always decorous, and his expression varies not; he is ever observant and reasoning.

The educational value of the Exhibition was fully appreciated as shown by the consistent attendance of artizans, apprentices and pupils; mechanics and manual workers rubbed shoulders with capital, big buyers and lesser labourers assembled together to hear of the merits and watch the performance of this labour-saver or that. Thousands of profitable short lectures were thus enjoyed, and shoals of illustrated catalogues were collected as reminders of the object-lessons.

Enquiry of the exhibitors showed that a great deal of real business had been done. Very many had to report a gratifying list of completed sales, and as to promising enquiries and useful additions made to business connections, there were no end. And it is, after all, the opinion of the exhibitor as to the success of the Exhibition which is the most telling; he it is who bears the expense in the first place, and who therefore practically decides whether or not an exhibition shall take place; if profit rewards his enterprise then only is the exhibition a real success. The business done at the Engineering and Machinery Exhibition of last year rendered the promotion of this year's show a comparatively easy matter, although it has been generally said that twelve months is all too short an interval to allow between successive exhibitions of this class. As to whether the Engineering Exhibition will become an annual affair after the lines of the Grocers', Bakers', Leather-sellers', Motor-car, and similar exhibitions is doubtful; but it would appear that progress

in engineering matters being rapid, the range of subjects illimitable, and the machinery of manufacture entering ever more closely into all conditions of industrial life, there is some necessity for a general machinery market or exhibition to be held in London every year. There is nothing like an exhibition of the class under notice for showing the manufacturer of every-day commodities where his rival is getting ahead of him, or the way in which he may himself steal a march on competitors. "Comparison" is writ large over the entire show; comparison as between neighbours' work and nations' work. The exhibitor-salesman and the visitor-buyer are both placed absolutely on their mettle, and business done under these conditions is gratifying to both.

The Exhibition as a whole was of first-rate electrical interest; there were many all-electrical exhibits, but apart from these the electric drive was practically universal wherever running machinery was shown. Almost every leading electrical firm had some examples of motors in actual service. Belt drives, direct-coupling, spur-gears, friction drives, silent chains, variable-speed control, reversing and tramway type controllers, &c., &c., were all in constant evidence; there were motors on floors, columns and overhead joists; motors built into the frames of heavy tools, mounted on travelling platforms, forming the body of portable tools and devices. There were arc lamps of every type, incandescent lamps of all shapes and sizes, electric lighting novelties and displays; electric furnaces, electric welding; penny-in-the-slot meters; gas and steam-driven generating units; and dozens of electrical novelties and applications too numerous to mention. Although electric power and lighting practically held the field, there were still some few examples of pneumatic tools and patent gas-lighting plants.

It would be invidious to single out any particular one or two exhibits as of exceptional prominence. Metal-working machine tools were in the aggregate, and the latest patterns of British, Continental and American origin were well represented in the small and medium classes. There were not many heavy machines: there were some examples of punches and shears, and a noteworthy exhibit of plate bending and straightening machines. In the way of engineering shop tools, the present popularity of the grinding method was in full evidence. In general, the whole range of tools showed the solidifying effect on design of the common use of high-speed steels and the tendency to more than ever increase the number of cuts and processes effected simultaneously on the one machine. The more important examples, and some of the newer machines, were described at length in THE ELECTRICAL MAGAZINE of last month. Other noteworthy exhibits of this class are dealt with in another part of this number. Owing to pressure on our space we have been compelled to hold over descriptions of several exhibits of interest and merit, which we propose giving in our next issue.

Mining and quarry plant formed quite a feature, a coal-mining surface plant attracting a good deal of attention, the successful design of a picking and screening plant, consisting of a series of troughs swinging on ball bearings, marking a distinct practical advance. A particularly notable device was a newly-introduced mining cage, which for absolute safety in automatic catching has points far superior to anything we have yet seen. Compressed air and petrol rock drills, portable compressors, rock crushers, and kindred appliances were shown by several leading firms.

The phenomenal development of the petrol engine and the motor vehicle industries was exemplified by the great number of special tools exhibited for accurate repetition work on the small parts of petrol power equipments. Not only were cylinders, valves and gears shown in process of working up and finishing, but wherever an exhibitor had a special means of filling cracked castings, welding or brazing breaks, he was always showing how motor-car or petrol-engine failures could be rectified. This unanimity on the part of the "repair-better-than-new" man seemed to give an amusing confirmation to the story told daily in the City streets by the derelict 'bus or motor-car. The petrol engine plays one of the greatest parts in engineering development to-day.

Many of the leading engineering journals were represented at stands dotted here and there over the hall. The stand of THE ELECTRICAL MAGAZINE, of which an illustration appears on page 230, was largely resorted to by those seeking information on electrical power matters and desiring books relating thereto. As will be seen, the stand was particularly conspicuous by reason

of its effective lighting. The merits of the Suterlite, the long tubular incandescent lamp hidden in its trough-shaped reflector, was fully appreciated by visitors seeing the excellent desk- and bookcase-lighting effects secured. In both cases the objects were suffused in a flood of light directed over the desired area, without the source of light being within sight. The same class of light served also to give the general illumination to the interior of the stand; the lengths of lamps being placed out of sight behind the top signs. In addition to the Suterlite good use was made of the "Witelite," a speciality of the General Electric Company; in this a spherical bulb lamp having the lower half of the glass frosted is combined with a neat white porcelain reflector placed immediately above the lamp bulb. The result obtained at THE ELECTRICAL MAGAZINE stand was a pleasant and well-diffused yet brilliant lighting effect which attracted many people to the exhibit. We refrain from going into details as to the general merits and utility of our exhibit. The picture tells its own story.

THE STAND OF THE ELECTRICAL MAGAZINE AT OLYMPIA.

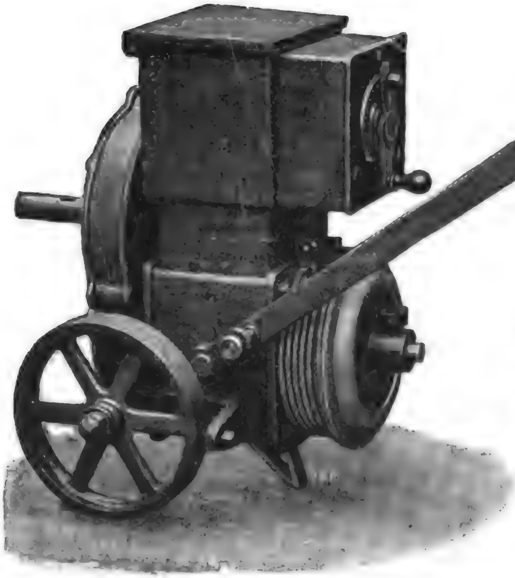


FIG. 1. A CARRIAGE ELECTRIC DRILLING MACHINE.

Portable Electric Tools.

S. Wolf & Co., London, S.E.

THE ever-increasing demand for light, portable electric tools has brought about a considerable range of designs in those made by Messrs. Wolf. In every case, whether the motors be applied to drills, grinders or polishers, the motors themselves are designed and built just as would be the case for dynamos of many kilowatts capacity. They are of the protected type, having cast steel frames, with laminated pole pieces bolted in. The armatures are wound on slotted drums, each coil being secured in place by fibre wedges driven in slots above the conductors. The commutators are

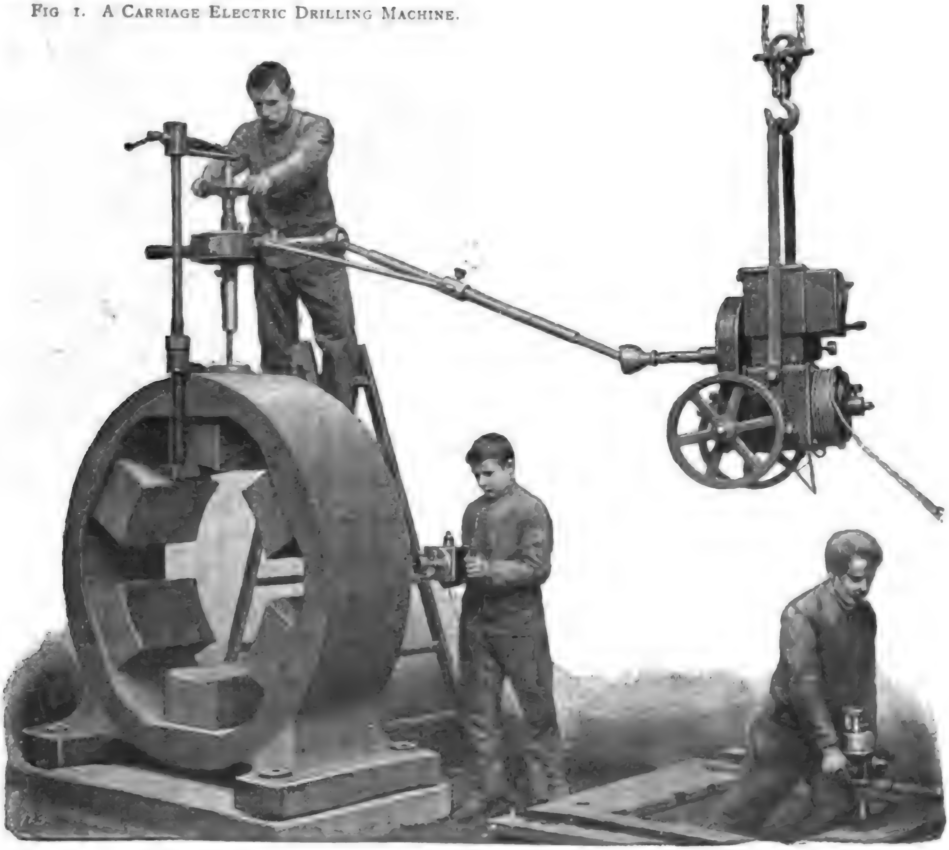


FIG. 2. SHOWING THE ABOVE ELECTRIC DRILLING MACHINE AND ALSO HAND ELECTRIC DRILLS IN USE.

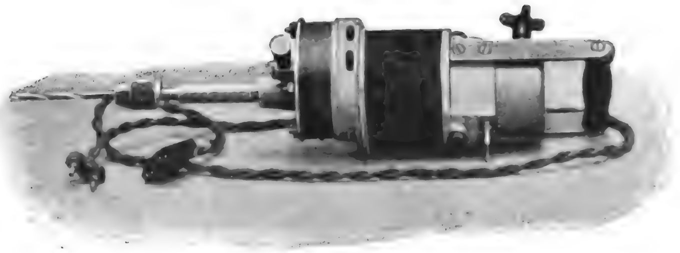


FIG. 3. FEATHERWEIGHT ELECTRIC DRILL.

accurately built and assembled under hydraulic pressure. It is stated that all armatures are subjected to a test of 1500 volts. When one considers that the armatures in many cases are not more than about 2in. in diameter, the good work which is put into them is very obvious. The tools are fitted with either a.c. motors or with single or polyphase motors for pressures up to 500 volts. In the case of the a.c. machines the same perfection of construction has been observed. The illustrations, Figs. 1 to 5, give typical examples of the tools shown. In all cases the motors run at constant speed, and where

FIG. 4. SENSITIVE DRILL WITH MOVABLE TABLE.

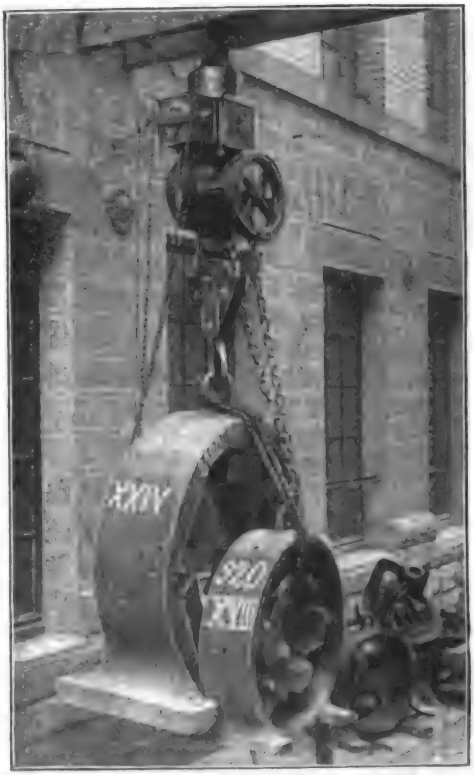


FIG. 6. ELECTRIC HOISTING BLOCKS IN USE.

FIG. 5. SMALL ELECTRIC GRINDER.

Fig. 7. Small High-tension Transformer.

speed changes are desirable these are made by means of gearing. The speed changes are very simple: in the case of the drilling machine shown the depression of a lever and twisting it round through 120deg. brings in the several speeds one after the other. The starting switches are strong and simple, operating in either direction. In some cases reversing switches are provided, and these are of similar simple construction.

Another interesting small motor application is for hoisting tackle, which is shown in use in the illustration Fig. 6. It consists of an electric motor with a vertical shaft upon which is mounted a worm-wheel, a mechanical brake being also mounted on the lower end of the shaft. The worm is cut out of solid steel and drives a worm wheel of the best phosphor bronze.

The worm and worm wheel run entirely in oil in a dust-proof casing. The tackle gives a high mechanical efficiency, is claimed to be more durable than ordinary tackle, and introduces a large saving in working expenses.

The mechanical brake prevents the load falling from rest by its own weight. The lowering of the load is effected by the motor, this being set in operation from the floor by two cords, which actuate the reversing and starting resistance for lifting and lowering. The current is supplied by a flexible cable, which can be connected to the mains either permanently or at any required points by plug contacts.

All the electric parts are disposed inside a strong casing, and are thus perfectly protected from damage.

The blocks are made for direct or alternating current of any usual voltage, and are supplied in six different sizes from ½ ton to 20 tons load.

Another speciality shown by Messrs. Wolf is a small a.c. transformer for high voltages. These transformers are of the oil-immersed type, and are built for pressures up to 30,000 volts. The secondaries are provided with a number of tappings for giving variable ratios. Working examples were also shown of some well-constructed high-tension magneto generators as for motor-car and general petrol and gas-engine work.

Prepayment Electric Meter.

The Mordey-Fricker Electricity Meter Company, Ltd., Westminster.

The operation of this meter depends upon no new principle: it is merely a copper voltameter, but with a calibrated anode in the form of a roll of copper foil, and an ingenious reliable mechanism for the definite feeding forward of the anode in lengths corresponding to the number of coins paid into the meter, the gauge of the foil being fixed in each case according to the local prices of current.

The meter contains a glass depositing or electrolytic cell having the cathode fixed in the solution. The roll of thin copper strip

Fig. 1. General View of Mordey-Fricker Meter.

or ribbon is so mounted over the cell that it can be unwound so that the end of the strip, which forms the other pole or anode of the cell, dips more or less into the solution. The unwinding of this strip is effected by means of the prepayment mechanism, which is so arranged that by inserting a coin and turning a handle a definite amount of the strip is lowered into the liquid. Several coins may be paid in in succession, the length of the anode immersed being correspondingly increased. The cell being in series with the lamps the circuit is completed through the solution, and the current slowly eats away the copper from the anode and deposits it on the cathode. The eating away of the anode is gradual from the bottom upwards, this being ensured by the direction taken by the foil entering the liquid: the anode strip does not drop vertically into the cell or parallel to the cathode plate, but it converges towards the cathode; the low edge of the anode is consequently always nearest the cathode, and the electrolytic action is greatest at the anode edge. The total dissolution of the anode is thus assured and errors due to fragments of the anode falling away are prevented.

When the immersed portion of the copper strip is all eaten away the current can no longer pass, and the circuit is opened at the surface of the solution. Capillary attraction ensures the break of the circuit being absolute; when the current does fail the edge of the anode is quite clear of the liquid at once. The dimensions of the strip and the arrangement of the coin-controlled feeding roller are such that the payment of each coin ensures the supply of one coin's worth of current or energy. In this meter there is no motor, no clockwork, no switch, no counter—in fact, no mechanical action is involved except the simple hand operation of turning a handle each time a coin is put in.

The solution does not alter. It is of such a character that it does not evaporate. By adopting nitrate of copper as the salt of the electrolyte there is no "creeping" nor deposit of salts, nor does the salt tend to crystallize out. There is, of course, no chemical action on open circuit, and no temperature error.

The meter can be calibrated for any price per unit, and can at any time be adapted to any alteration of price or voltage by using a copper roll of a different thickness.

Fig. 2. Interior Cell and Mechanism of the Mordey-Fricker Meter.

The consumption or number of coins paid in is shown by numbers printed on the copper roll, these numbers being visible through the window in the cast-iron case.

The amount of prepaid energy available at any time is shown by the amount of the anode in the liquid. White glass rods are fixed behind the anode so that it can be easily seen through the window in the case. When the end of the anode is seen to be eaten away till it is near the top of the liquid, it is time to put more money in to prevent the circuit being opened.

The drop of volts across the meter is from .75 to 1 volt per ampere with one coin paid in. It is less with more coins paid in. For a few minutes before cutting off it is higher.

Four sizes or types of direct-current meters are at present being made, as follows:

Type	A.	B.	C.	D.
Coins used	Pence.	Pence.	Shillings.	Sixpences
Maximum amperes	3	1	3	3
Maximum feed	7d.	4d.	3/-	2/-
Capacity of anode roll	600 pence.	300 pence.	50/-	50/-

This meter is also made to take various foreign coins, including marks, half-marks, francs, four anna pieces, &c.

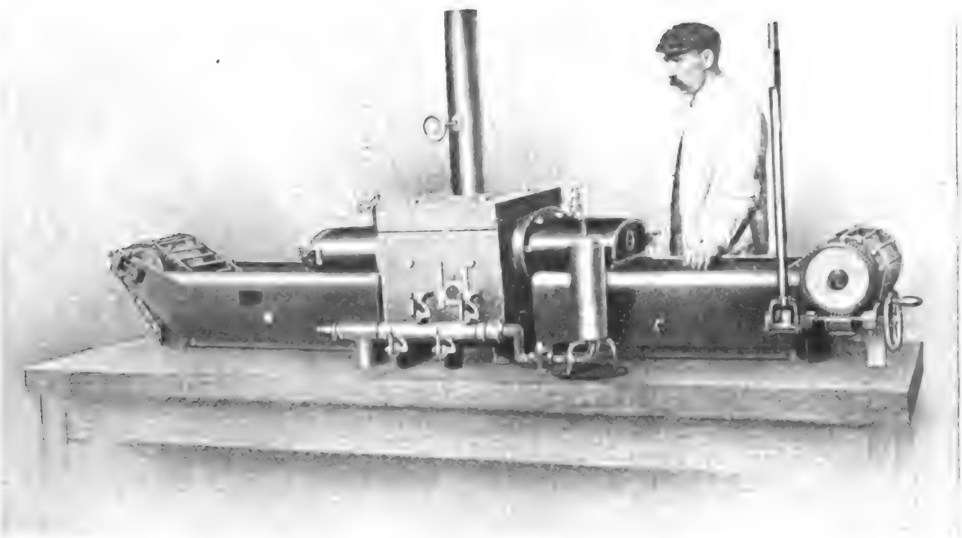


FIG. 1. JEWELLERS' ANNEALING FURNACE.

Annealing Furnaces, Paper Pinions, Electric Welders.

The Bates & Peard Annealing Furnace Company, Prescot.

An interesting exhibit of bright annealing was shown by the Bates & Peard Annealing Furnace Company. This has been on the market for some few years, and is meeting with an ever-increasing sale. Its special field of application is for the annealing of non-ferrous metals, copper, &c., and generally for all oxidisable alloys. Thus, for instance, it is used in the Royal Mint for the annealing of coin blanks. It is also used for a similar purpose in the Indian Government Mint, Calcutta, and in the French Government Mint, Paris. One of an exceptionally large size taking copper sheets 4ft. square is used by a Russian firm; others have been supplied to Italy, and, of course, many are

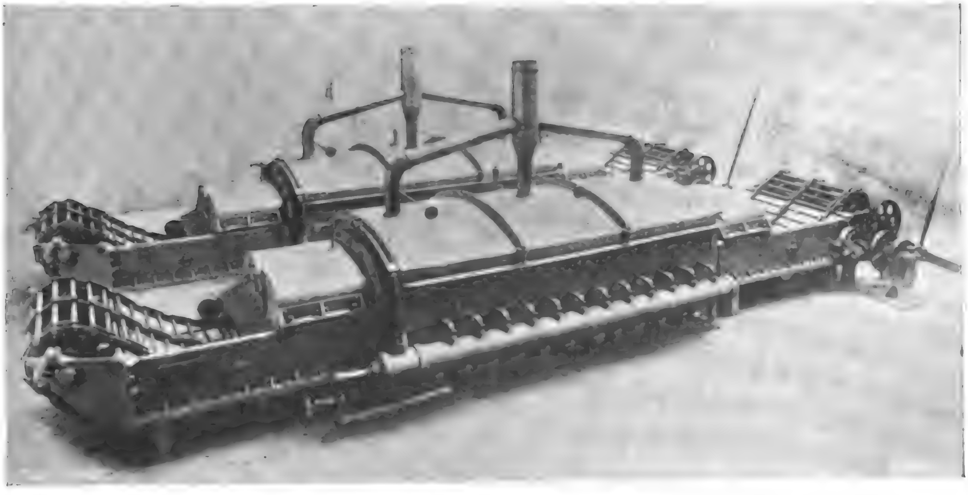


FIG. 2. TWO DOUBLE-TYPE FURNACES FOR ANNEALING COIN BLANKS.

FIG. 3. LARGE FURNACE FOR ANNEALING METAL SHEETS 4FT. SQUARE.

in use for the annealing of copper wires and conductors in various parts of this country and abroad by the leading copper merchants. It also finds considerable application in the manufacture of ammunition for the annealing of cartridge cases, &c.

The principle of the furnace is extremely simple. In general it consists of a retort heated by coal or gas or any other convenient external means. The retort ends slope down and dip into a water trough, thus the retort or annealing chamber is water-sealed at both ends. A travelling rack or chain serves to convey the materials through the water into the heated retort and out at the other end. The rate of travel is variable according to the section and quantity of material forming the charge. The form of the travelling chain is also adapted to suit the materials handled; thus coils of copper wire are merely laid on the grating, but where coins are being treated they are placed in special boxes secured to the chains. The atmosphere inside the retort is non-oxidising, this being obtained by means of a very small boiler discharging a jet of steam continuously into the retort.

The use of this furnace is attended with great economies in material and labour. It is stated that the smallest size, which costs £120, will handle 5cwt. of copper wire per working day of ten hours, and will give a net saving over older methods of annealing of 10s. per ton output. At the Exhibition the furnace was in operation, and visitors had full evidence of its efficacy as shown by the fine untarnished, well-annealed copper wires and foils turned out.

Of the illustrations, Fig. 1 shows the type designated a jewellers' annealing machine, that is to say it is a small compact furnace fired by gas, which can be placed on an ordinary workbench and used for the annealing of any kind of small articles. A very large number of these furnaces have been supplied to the jewellery trade in the Birmingham district for the annealing of all kinds of jewellery, with eminently satisfactory results. These little furnaces are quite self-contained, they can be fired by atmospheric gas burners, and have a small steam coil for generating sufficient steam to maintain a non-oxidising atmosphere. They have also an attachment by which the chain conveyor can be operated by hand so as to hurry through any article which requires annealing quickly.

Fig. 2 shows a bank of two double-type coin blank furnaces, which have been supplied to the Indian Government Mint at Calcutta for the annealing of coin blanks. These furnaces are also self-contained and fired by gas. A unique feature in this connection is the regenerative chambers between the firebrick lining and the body itself, through which the gas and air pass and absorb the waste heat radiating from the furnace itself. By this means the gas and air before coming to the ignition chamber are brought up to a very high and equal temperature, and the resultant economy in working is most marked.

A large and bulky furnace is shown in Fig. 3. This has been designed primarily for the annealing of large sheets of metal, and will take sheets up to 4ft. square, and

FIG. 4. COMPRESSED PAPER PINION.

piled on top of one another to the extent of 8in. or 9in. thick. The furnace, of course, has been designed for firing by coal, but the brickwork body into which this furnace is subsequently to be built is not shown, the photograph being taken after the assembly of the parts in the Bates & Peard factory.

Paper Pinions.

Another speciality exhibited by the Bates & Peard Company was a line of compressed paper pinions, manufactured by the British Insulated and Helsby Cables Company. These have been evolved to compete with raw hide pinions, and it would seem that they are likely to come into great popularity. Certainly the samples shown exhibited features of good construction and finish. Specimens were also shown of pinions which had been in use under very arduous conditions of load and surroundings for long periods. It is claimed that the compressed paper pinion is unaffected by moisture and oils. Judging by the makers' unique experience in the working of compressed manilla papers for cable work, &c., it would seem that this new pinion could be taken up by engineers with confidence.

Electric Welding.

An interesting exhibit of electric welding of metals of small sections attracted considerable attention at the stand of the Bates & Peard Company. The principle of these machines is not by any means new, but it is to the perfection of detail, whereby speed and effectiveness have been obtained, that the machines owe their popularity. They are built in a large range of sizes, the smallest being for the welding of wires, the largest sizes taking mild steel shafting up to 4 to 5

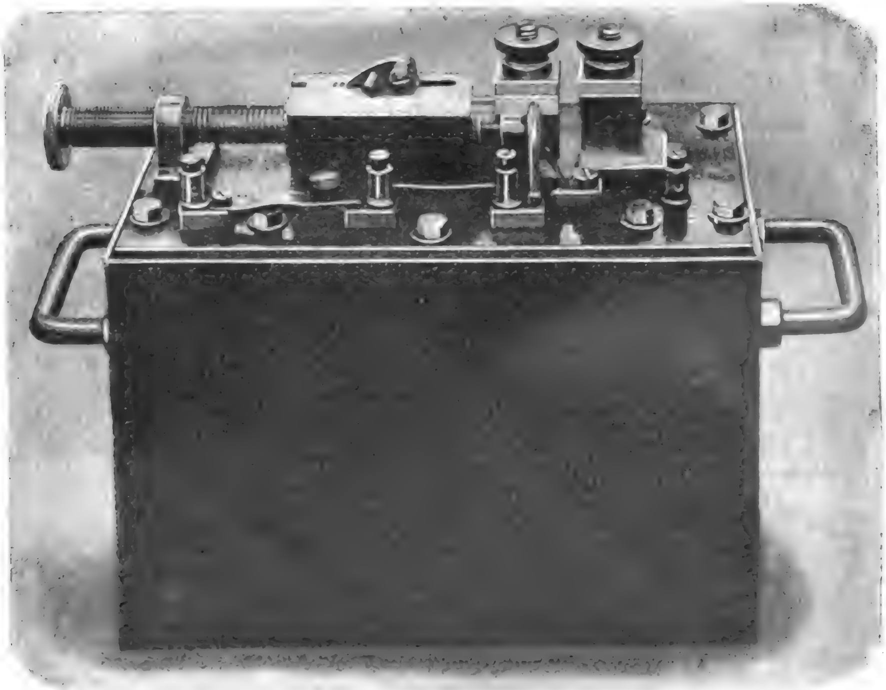


FIG. 5. SMALL ELECTRIC WELDING MACHINE.

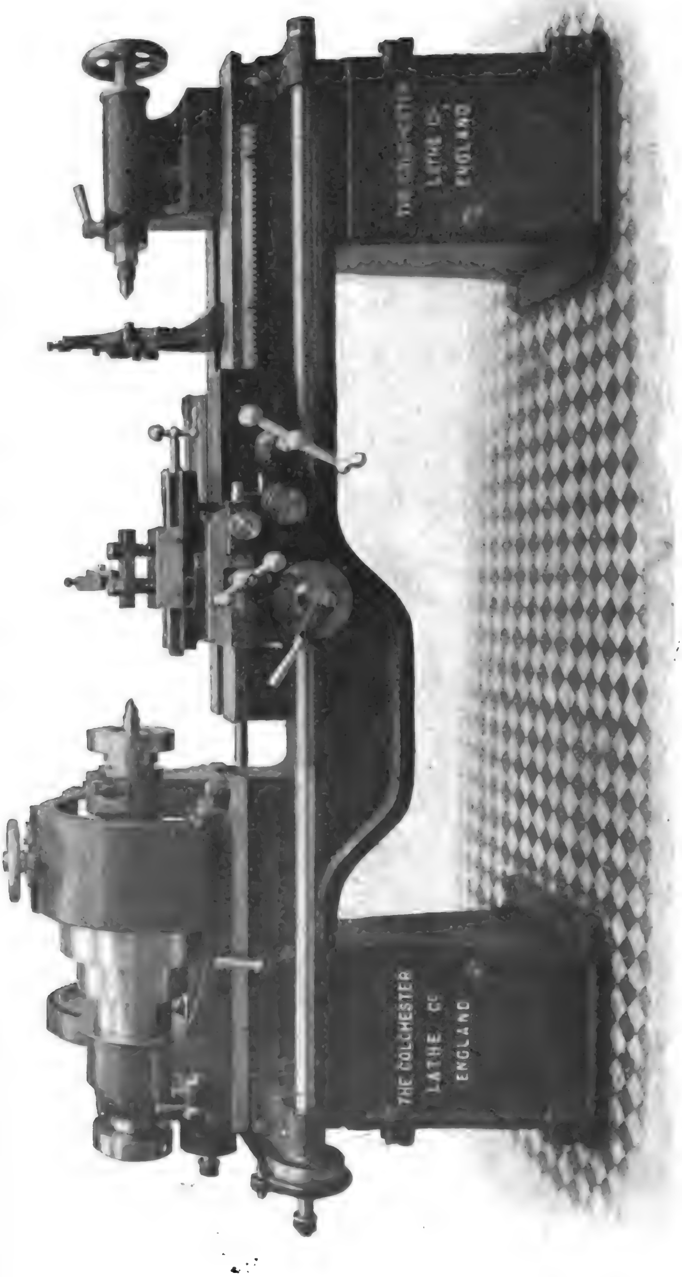
square inches in area. The particular machine shown is specially adapted for the welding of scrap copper conductors. The joints are made with great speed owing to an ingenious automatic electric cut-off, whereby the current is applied only for an instant to the welding of each joint and by which the current is only cut off when the welding is properly completed. Lengths of scrap wire welded in this way can be re-drawn to a smaller gauge, and the product is in every way as good as new drawn wire.

Mention should be made of the special welds which can be made by electrical welders. For instance, steel may be welded to copper, or to brass, and indeed most dissimilar metals and alloys can be welded with certainty by this means. In some cases, for special work, the electric welder is for this reason indispensable.

High-Speed Lathes.

The Colchester Lathe Company.

ONE of the most surprising exhibits was that of a new firm called the Colchester Lathe Company, Hythe, Colchester, who showed a 7½in. centre high-speed lathe. The important feature of this lathe is the headstock, which consists of a three-speed cone and system of gearing by means of which a very high belt speed is obtained, the countershaft running at 500 revolutions per minute. The lathe easily reduces by a single cut a 4in. bar to under 3in. at 36 cuts to the inch, and takes a ¼in. deep cut at 72ft. per minute with a feed of 12 cuts to the inch. The spindle has a $2\frac{1}{16}$in. hole



HIGH-SPEED LATHE OF THE COLCHESTER LATHE COMPANY.

through it, and is fitted with a ball thrust. The bed is fitted with a half gap piece. The lathe will swing 11in. over the saddle, 26in. diameter by 8in. wide in gap, and admits 3ft. 2in. between centres. The loose headstock is of a very rigid design with 2in. dia. barrel. Adjustment for taper turning is provided. The leading screw is ½in. pitch and is fitted with double phosphor bronze clasp nut. The saddle has an extra long bearing on the bed. The rack and all pinions are of steel, while the self-acting motion is put in and out of gear by means of a small lever which controls a clutch and eccentric device. The lever is conveniently placed in front of the saddle as illustrated. The self-acting feeds are positive, being obtained by gearing from headstock to the back shaft, with lever control in the front. Three feeds are provided, viz., 12, 24, 36.

The several lathes of this exhibit were driven by an electric motor built by E. B. Gray, Colchester. A striking feature of this machine was its liberal design; it was a typical machine for the workshop.

Combined Hand and Steam Steering Gear.

Dunston Engine Works Company, Gateshead-on-Tyne.

THIS gear is a development of Archer's well-known patent self-holding hand steering gear. By a simple clutch arrangement it can be used either as a hand gear

COMBINED HAND AND STEAM STEERING GEAR.

from the large wheel, or worked direct from the engine and controlled by the small wheel, the large wheel being then out of gear. The novel feature of the gear is that all the working parts, apart from the engine, are carried on one shaft, and the wheel-gearing used is the patent cycloidal arrangement which is the principal feature of Archer's hand gears. The requisite power is obtained by means of the cycloidal arrangement without the use of worm or other wheels, and a high efficiency is the result.

The mechanical arrangement of the gear will be seen from the illustration on the preceding page. It is of rigid and compact construction, yet at the same time special care has been taken in the design to make all working parts, both of the gear and the engine, accessible.

Steam-Electric Generating Sets, Projector Lamps, Pumps, Winches, Capstans, Water-Tube Boiler, &c.

Clarke, Chapman & Co., Ltd., Gateshead.

THE machinery exhibited by Messrs. Clarke, Chapman & Co. represented fully the high-class nature and special field of the work turned out by this well-known Tyneside firm.

Electric Generating Sets.

The following is a description of the combined single-cylinder engine electric plant shown, which was one of a large number of different sizes of the type supplied principally for ship-lighting purposes. The engine cylinder in this case is 8in. diameter by 8in. stroke, and is cast in one piece with the back column. On the face of the column is formed the cross-head guide. The bedplate is specially stiff, and in it are formed the two crankshaft bearings. It is also arranged to collect any surplus oil, and a drain-cock is fitted to draw this oil off.

The crankshaft is machined from the solid steel forging, and is fitted with heavy cast-iron balance weights. The flywheel, which is fixed on the end of the shaft remote

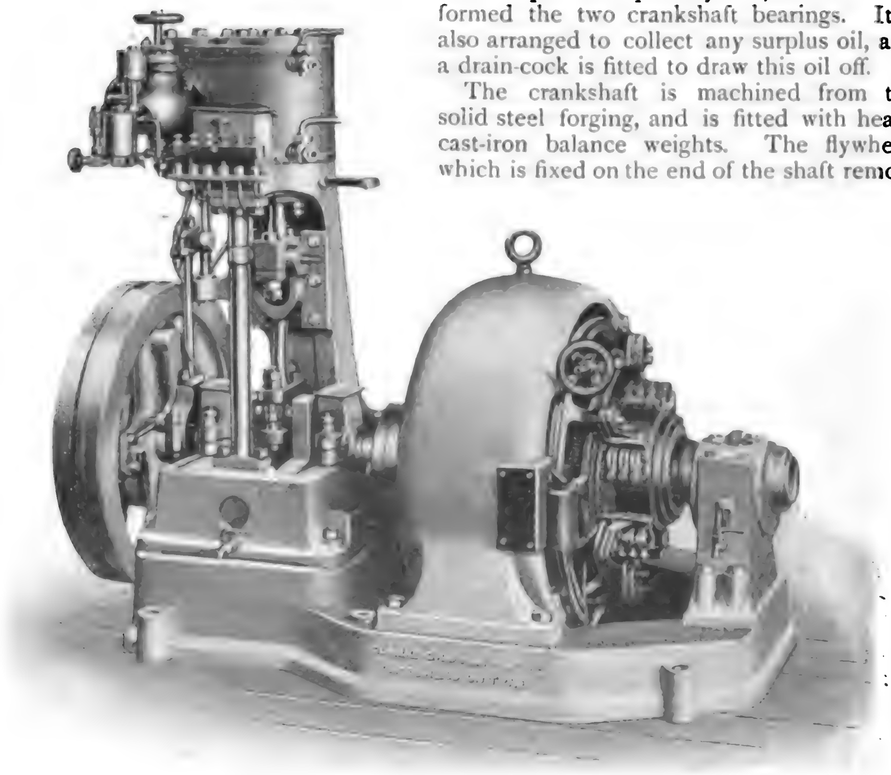


Fig. 1. Single-Cylinder, Direct-current Generating Set.

from the dynamo, contains an automatic governor, of which the eccentric forms a part. The governor is made up of two sets of balance weights and springs, each set being coupled by connecting links to the eccentric sheave. The movement of the governor weights is transmitted to the eccentric sheave in such a manner that not only the travel, but also the angle of advance is varied, so that with light loads the number of expansions of the steam is greater.

The piston is of cast steel, and fitted with Ramsbottom cast-iron rings. The slide valve is of the piston type.

A large oil-box is cast on each main bearing, and a syphon tube fitted; all the other bearings are lubricated from a large oil-box fixed on the front of the engine, a separate pipe being led to each bearing. At the upper end of each of these oil pipes is fitted a separate adjustable sight feed. A cock is fitted to the oil-box, by which means the supply of oil can be cut off without interfering with the separate adjustments.

The dynamo is of Messrs. Clarke, Chapman's multipolar slotted drum armature type, and is mounted on the same bedplate as the engine. The yoke is of cast iron, and is fitted with six wrought-iron poles. The brush-rocker and the terminals are mounted on the magnets, and a hand-wheel is provided for adjusting the brushes circumferentially on the commutator. On the armature shaft is mounted a spider carrying the armature core plates and the cast-iron commutator bush.

The armature core plates are of charcoal iron slotted for the armature bars, mounted on the cast-iron spider, and positively driven by a wrought-steel key. The armature conductors are of high conductivity copper bars, double cotton covered, thoroughly insulated from the core plates, and well protected from the binding wire.

The "V" rings of the commutator are insulated from the copper segments by means of micanite, pure mica insulation being used between the segments themselves. Before the commutator is assembled, it is heated, and while in this condition is subjected to hydraulic pressure and then locked by an end ring screwed on the commutator bush. The commutator end connections are riveted and soldered in the segments. The outer ends form the fork into which the armature bars are soldered.

Aluminium brush-holders are fitted, each brush-holder being arranged to take either two or three brushes, and the pressure between each brush and the commutator is adjustable. The brushes are connected to the brush-holders by flexible wires. The armature shaft is lubricated in the usual manner by means of two loose oil-rings, which dip into a large oil well formed in the bearing pedestal. The bearings throughout are of ample proportion, and special attention having been paid to the lubrication the whole plant is well adapted for long and continuous running.

A second generating set on exhibit was of the enclosed compound type, having an output of 350 amperes at 100 volts when running at a speed of 450r.p.m., with steam at 100lb. per square inch pressure, and working non-condensing.

The engine cylinders are 8¾in. and 14in. diameter by 7in. stroke. The bearings are all enclosed in the cast-iron crank casing and bedplate. A stuffing-box is fitted at the top of the crank casing for each piston-rod, and

FIG. 2. CLARKE-CHAPMAN PROJECTOR.

there is one inch more length between the glands of these stuffing boxes and those on the cylinders than the stroke of the engine. This prevents the passage of oil from the crank casing into the cylinders, and thence to the condenser if the engine is run condensing. Two large doors are mounted on the front of crank casing and two at the back, giving full access to the bearings.

The bearings are liberally proportioned, and, the lubrication being by means of a force pump coupled to the high-pressure eccentric sheave, the plant may be run for long periods with a minimum of attention.

The governor is mounted on the crank-shaft, and being inside the crank casing it is automatically lubricated by the oil spray from the bearings. An adjustable spring is fitted in an accessible position near the throttle valve. By means of this adjustment the speed may be varied 5 per cent. above or below the speed for which the governor is set.

An indicator gear is supplied with each set of engines.

The vibration which is always present more or less in all high-speed engines is reduced to a minimum in this engine by having the centres of the cylinders reduced to a minimum and the cranks set at 180deg.

The dynamo is a larger size of the same type as that coupled to the open-type engine.

These engines have been supplied to a considerable number of mail steamers.

The proportions of cylinders make the engine suitable for running condensing when at sea, or exhausting to the atmosphere while in port.

The engines are made to the requirements of the British Admiralty and various large shipping companies, to whom large numbers of plants have been supplied.

Projector Lamps.

The 24in. projector exhibited was of the same type as a large number supplied to British and foreign war vessels as well as other steamships.

The barrel or hood is of sheet steel, stiffened at each end. The glass parabolic mirror is carried in springs fixed on a steel ring which fits in the hood. The fixing is by means of a bayonet joint, so that the mirror is easily removed. The lens, which

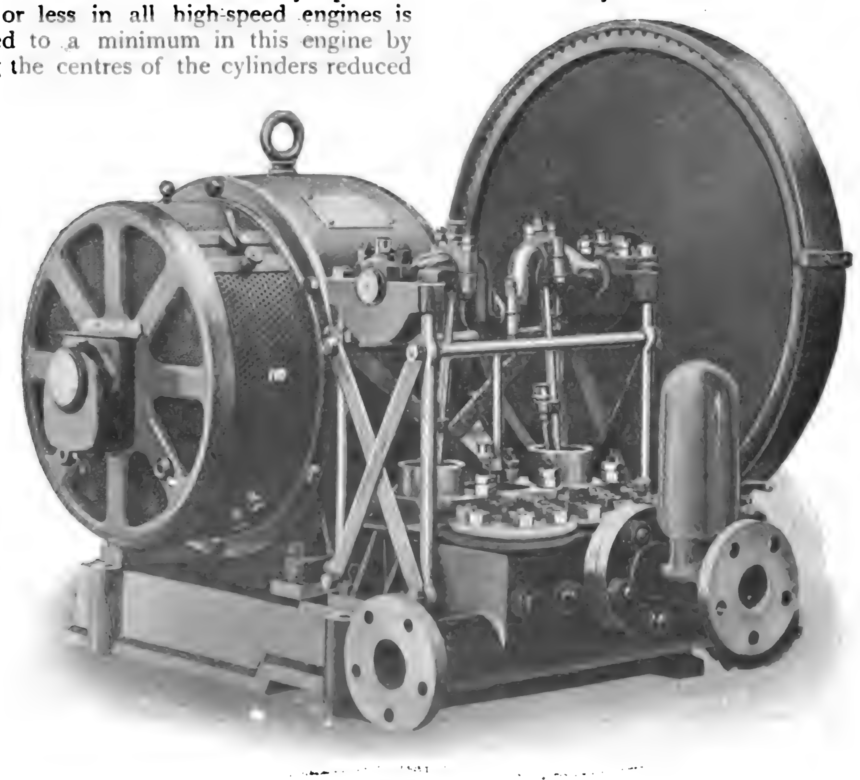


FIG. 3. ELECTRIC THREE-THROW PUMP.

is suitable to give a wide flat beam of light, is also fitted with bayonet joint, and so easily removable.

A combined automatic and hand-feed lamp is fitted, having carbon-holders which are adjustable horizontally and vertically to bring the carbons into correct alignment. The arc is brought into focus with the mirror by means of a handwheel and screw with a nut sliding in guides on the lamp frame and engaging with the lamp body.

The vertical and horizontal movements of the projector can be effected quickly by hand, or slowly by means of a rack and pinion fitted for each of these movements.

The ventilation has been carefully arranged to make it most efficient. The current consumption in this size is 100 amperes.

Several different types of projectors can be supplied by the firm in sizes ranging from 12in. to 36in. in diameter. The lamps may be as above or fitted only with hand-feed, whilst they may be fitted without lens, with single lens as above, or with two lenses, the second one giving a divided beam of light as required for Suez Canal requirements, or two motors can be fitted in the base of the projector, making it suitable for operation by a controller fixed some distance away.

Electric Pumps.

An electrically-driven three-throw pump, Fig. 3, of the 3in. by 3in. size, was shown. This operates at a normal crankshaft speed of 140r.p.m., and has cylinders and plungers of gunmetal, and in the pump shown all the parts that come in contact with water are tinned, thereby making it suitable for fresh water service.

The bent steel crankshaft is carried in two bearings, which are fixed on well-pressed wrought-steel stanchions.

On the end of the crankshaft is fitted a cast-iron spur wheel, which gears with a raw hide pinion mounted on the armature shaft of the motor. This gearing is protected by a substantial cover.

The motor is of the shunt-wound four-pole protected type, and is capable of exerting 2h.p. at 750r.p.m.

The motor and pump are mounted on a substantial cast-iron bedplate, and the whole makes up a most compact design. This pump is capable of giving an output of 1800 gallons per hour against 100ft. total head.

Electric Winches.

Of the two electric winches shown the three-ton shipyard pattern, Fig. 4, exhibited special features; it has double warp ends, which allow of a speed being used suitable to the load, and the barrel is independent of the shaft, which gives greater freedom in handling loads. The winch is arranged with the motor driving the barrel and warp ends through three sets of spur gear. The motor pinion is of raw hide engaging with a machine-cut cast-iron wheel. The barrel is

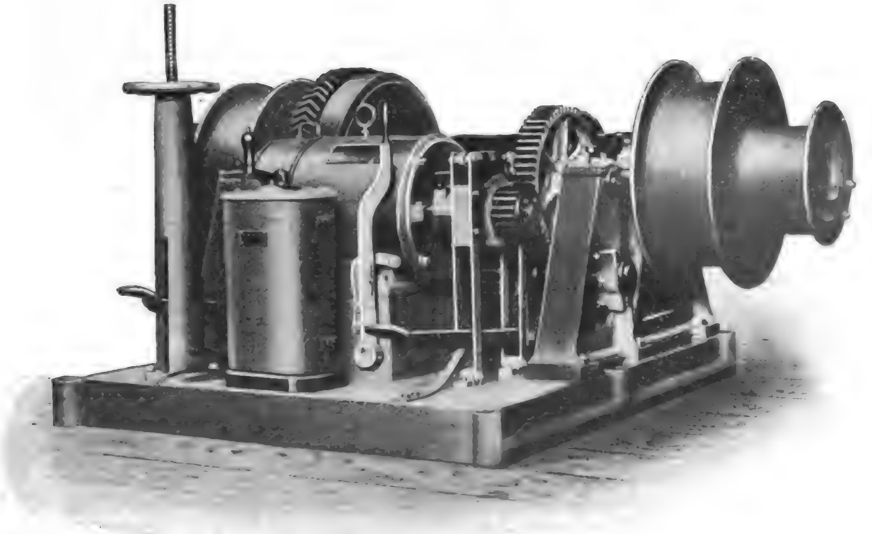


Fig. 4. Clarke-Chapman Electric Winch.

loose on the shaft and fitted with a clutch for throwing it into gear; it is provided with a foot-brake fitted with a screw, which allows of a load being held suspended from the barrel while the warping drums are being used, a foot-brake on the motor pinion controlling the latter. The warp ends are provided with two diameters, the small end giving a speed of 40ft. per minute with three tons, and the large end a speed of 80ft. per minute with one and a half tons.

The motor is of 12h.p., and as it is series-wound light loads can be lifted at faster speeds. A tramway-type reversing controller and the resistances are mounted on the bed-plate, making the winch self-contained, the whole being of a substantial design well calculated to take the strains coming on it.

The other winch exhibited is a type of hoist as supplied for various purposes, such as lifting ashes out of the stokehole of a ship or mails out of the hold. The arrangement of two-lever control with a constantly running motor make it specially suitable for warehouse quick-lifting work.

It consists of a compound-wound motor driving the barrel through a worm-gear reduction. The worm-wheel is of gunmetal with machine-cut teeth, and runs in an oil-bath cast with the motor body; all end-thrust is taken on friction washers. The motor runs constantly, the barrel being loose on its shaft. By lifting a clutch-lever a friction cone is brought into gear with the barrel and the load lifted, an automatic brake holding the load when the clutch-lever is dropped.

To lower, the brake-lever must be slightly raised. The starting switch is formed in the motor body.

Electric Drill.

The electrical exhibits of Messrs. Clarke, Chapman also included an electrically-driven drill. The motor is of the two-pole totally-enclosed type, and is mounted on the end of the adjustable arm. A screw is formed in the adjustable arm into which a pinion gears; by this means the drill is easily moved to or from the drill-post, and the arm being circular allows the drill to be directed in any direction. A double clamp carries the arm on the drill-post.

In a casing fixed on the motor a two-speed gear is fitted having the ratios of 2 to 1 and 4 to 1 respectively between armature shaft and drill spindle.

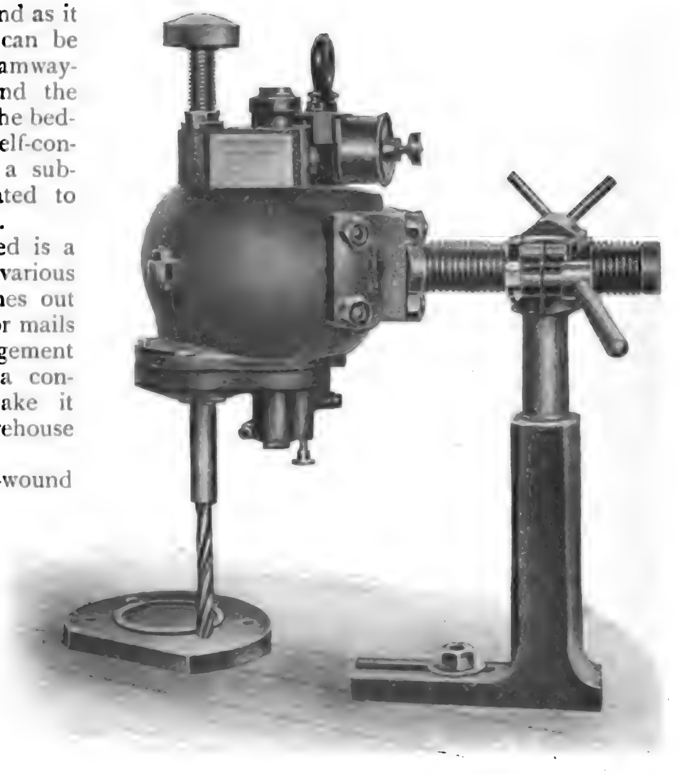


FIG. 5 TWO-SPEED ELECTRIC DRILL.

The motor being series-wound a large range of speed is obtained. A tool box forms part of the equipment, which contains all spanners and keys required, also a set of twist-drills $\frac{1}{8}$in. to $\frac{3}{4}$in., advancing by $\frac{1}{16}$ths, and set of short-twist drills $\frac{3}{8}$in. to $\frac{3}{4}$in., advancing by $\frac{1}{8}$ths.

The motor is $\frac{1}{4}$b.h.p., and at full load runs at 750r.p.m.

Wate-tube Boiler.

Messrs. Clarke, Chapman & Co. also made an exhibit of their recently introduced water-

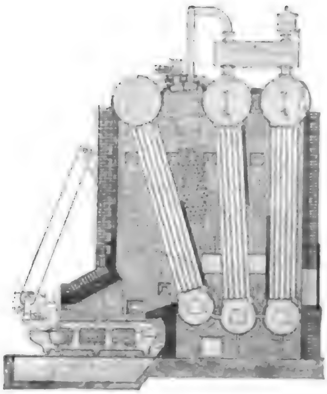


FIG. 6. THE WOODESON WATER-TUBE BOILER.

tube boiler, Fig. 6, which is receiving considerable attention from power engineers, and is already well advanced in public favour. The exhibit showed a steam drum of the Clarke-Chapman water-tube boiler, "Woodeson's Patent." It is formed from steel plates made by the Siemens-Martin process, and having a tensile strength between 28 and 32 tons per square inch. The tube plate is formed into the required shape by hydraulic pressure in one heat. This drum is arranged for four groups of tubes, but steam drums have been made with tube plates for as many as ten groups of tubes. Over each group of nineteen tubes is arranged a 13in. and 16in. manhole through which any tube in that particular group can be withdrawn or replaced if necessary.

The special advantages claimed for this boiler are:

Free access to all parts, whether for examination, cleaning, or repairs, as by taking off one manhole door at the top drum and one manhole door at the bottom drum, every tube in that particular section can be easily examined in a very short time; the fact of the tubes being perfectly straight makes this process extremely simple.

All heating tubes are perfectly straight, of the same length, and are vertical; there are no joints exposed to the heat of furnace gases.

All parts of the boiler are free to expand.

All heating tubes are the same length, and an unobstructed view is obtained through each tube for inspection.

Free access can be made to every part of the boiler, and the design is such that in the circulation only the cleanest water gets to the tubes immediately exposed to the hottest gases.

The water drums are of very large area, which enables dirt and deposits to be easily collected and blown away. The combustion chambers are large and construction and design extremely simple. The design in general is so arranged that all the demands and requirements of boiler insurance companies and other experts are fully met.

The manhole doors are made of thick, mild steel-plate, recessed out for the reception of soft asbestos packing rings.

The two end plates are dished and flanged by hydraulic pressure, and the edges turned up in a lathe. All other plate edges are planed, and all rivet holes drilled in position. After all flanging and drilling is finished each plate is carefully annealed.

A great number of these boilers are now working under the following various conditions, namely:

With hand firing.

With mechanical stokers of various types.

Utilising waste from steel furnaces, forges, &c.

Waste heat from coke ovens.

Blast furnace gases.

And the success with which they are all working is verified by the greatly increased demand and the large numbers of repeat orders which are constantly being received.

Steam Windlasses.

A steam windlass was also shown consisting of a double cylinder horizontal engine arranged to drive two cable-holders, which are mounted on the main shaft by means of spur gearing. The windlass is also fitted with two warp ends on the ends of the second motion shaft, the main wheel pinions being fitted with clutches so that these warp ends can be worked without working the main shaft when required. The cylinders are each 6in. diameter by 9in. stroke, and together with their respective valve chests and reversing valve chest form one casting of iron. The slide and reversing valves are of cast iron and of the flat D type. The reversing valve is arranged to be worked by means of a lever placed at the back of the cylinder. All the pinions of the gearing are of cast steel, the wheels of cast iron. The engine gearing and frames are mounted on one cast-iron bedplate which is planed level on the underside.

The cable-holders are of cast iron, and

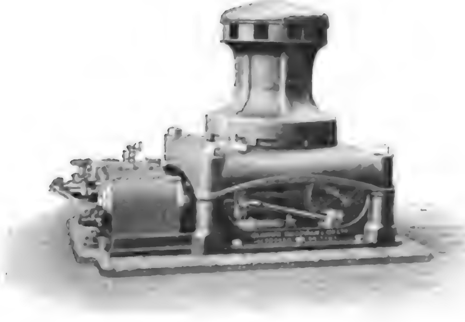


FIG. 7. STEAM CAPSTAN.

are of the patent direct-grip type which have projections formed on the face engaging with similar projection on the main wheels. The cable-holders are put in and out of gear by means of specially designed withdrawing gear. Powerful screw wood-lined band-brakes are fitted to each cable-holder for controlling same when veering. Hand-gear is fitted to work windlass by hand when steam is not available. All the bearings are brass-bushed and adjustable.

The windlass is arranged to work stud-link cables 1¼in. diameter. They can be made either with vertical engines or horizontal, either with the cylinders cast all in one as exhibited, or with separate cylinders. They may also be fitted with link-motion reversing gear, instead of the differential type of reversing valve gear.

Over 2000 of these direct-grip type windlasses have been supplied during the last six years either with vertical or horizontal cylinders, and ranging in sizes capable of dealing with ¾in. up to 3⅛in. diameter stud-link cables.

They have been supplied to all the most important shipping companies in the world, also special designs of windlasses have been fitted to several war ships of British and foreign navies.

Steam Capstans.

The steam warping capstan shown in Fig. 7 consists of a double cylinder horizontal engine arranged to drive a vertical warping capstan, which is placed immediately above the engine, by means of worm-gearing. The engine and gearing are carried on one strong cast-iron bedplate into which the capstan spindle is stepped. The cylinders are each 6in. diameter by 7in. stroke, and together with their respective valve chests and reversing valve chest form one casting.

The slide and reversing valve are of cast iron and of the flat D type. The reversing valve is arranged to be worked by means of a lever placed at the back of the cylinder.

The worm is forged solid with the engine-shaft, and is correctly machined to work into a cast-iron worm-wheel which has machine-cut teeth. All the bearings are brass-bushed and made adjustable where possible, and are fitted with lubricators.

The capstan barrel is cast iron, and has bar holes arranged at the top so that it can be worked by hand power and has a pawl rack at the base for engaging with the pawl.

The capstan exhibited is arranged to exert a strain of two tons on the rope at a speed of 40ft. per minute, with a steam pressure of 90lb. per square inch at the cylinders.

Most of the important shipping companies have their vessels fitted with these gears.

Steam Winches.

There was also exhibited a horizontal steam winch of the "Cyclops" type, fitted with double cylinders 7in. diameter by 12in. stroke, and heavy type link motion reversing gear having exceptionally large diameter pins and wearing surfaces. The gearing is single and double purchase, the wheels being of cast iron and pinions of cast steel bushed with brass, all teeth being double helical.

All clutches work on square shafts. The barrel is of large diameter suitable for working with steel wire-rope, the length of the barrel being reduced and the winch narrowed in. The barrel shaft is fitted with large diameter warping ends, and the quick-speed shaft with large diameter whipping drums on both sides. The winch is also fitted with powerful foot brake, steam stop valve, steam and exhaust pipes of copper between the two cylinders, drain cocks at each end of cylinders coupled together to exhaust pipes, provision for working by hand, all necessary lubricators, &c.

The great demand for Clarke-Chapman winches has resulted in the firm putting down a very large special plant capable of turning out large numbers; they are thus able to guarantee all parts duplicate, which is a great advantage when replace parts are required. Modifications and improvements are continually being made to meet the special requirements that are constantly

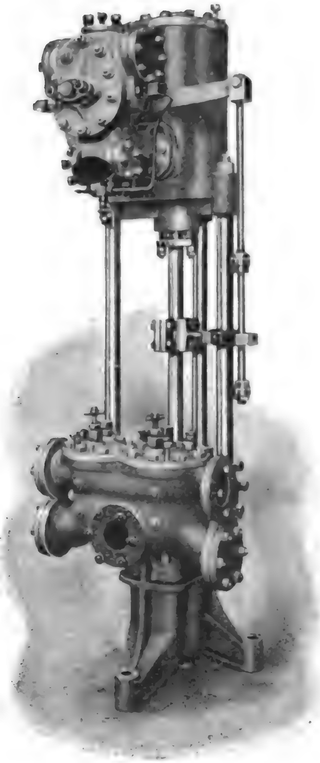


Fig. 8. Woodeson Feed Pump.

occurring, and the large and continually increasing output is sufficient evidence of the satisfaction given to users.

Steam Pumps.

The Woodeson patent pump has now been upon the market some seven or eight years, and during this period has proved a great success, as the very large and ever, increasing demand shows.

The special feature of this pump is the extremely simple and efficient valve gear with which it is fitted.

This gear is of the Corliss type and consists of two small auxiliary Corliss-type valves and one main distribution valve of the same type, and, unlike most other valve gears where the auxiliary valves alone are positively moved, the whole of this gear, including auxiliary and main distributing valves, is mechanically moved before the main valve is given its final movement by the action of the steam.

This is a great advantage as it enables the steam to be used most economically by reducing the area of the steam port during the travel of the piston, and this period of the main steam port allows the pump piston-rod to slow up at the ends of the stroke, and so eliminates shock in pipes.

Another great advantage is that no valve setting is required, as it is impossible to put this valve gear together in any other but the correct way.

When the pumps are standing for any length of time the whole of the inside of the valve gear can be moved as often as required by means of the external lever attached to the tappet-rod spindle; by this means the valve faces may be kept free from rust and dirt when standing.

The pair of pumps exhibited have steam cylinders 8in. diameter, water cylinders 6in. diameter, length of stroke 18in., and are mounted on a cast-iron float tank, and fitted with automatic controlling gear. Each pump of the pair is capable of easily dealing with the feed-water for engines of 1400i.h.p., the other being a standby.

The pumps exhibited were designed especially for marine work but they are also made in a variety of different forms.

For central power stations and all installations where economy in steam is a great consideration they are made with compound cylinders either of the tandem or twin cylinder type, and large numbers of these are at work. They can be made vertical and horizontal and have been supplied for practically all purposes for which a direct pump is admissible.

Two small pumps are also exhibited fitted

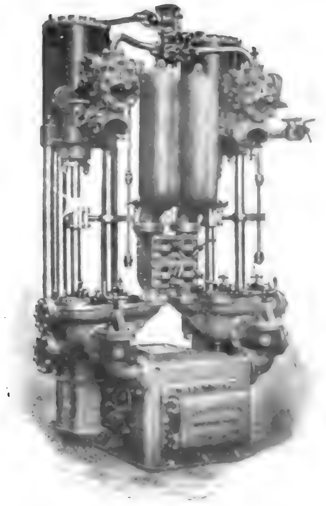


Fig. 9. Duplex Steam Pump.

with same valve gear and which have been specially designed with a view of providing a really substantial pump at a very moderate price. A few modifications have been made but the general design is similar to that of the standard pumps.

Still another exhibit was the duplex pump which is fitted with steam cylinders 12in. diameter, water cylinder 8in. diameter, with a stroke of 10in., and which has been designed to meet all British Admiralty and other first-class requirements. It has been largely used to work See's patent ash ejector, which requires a particularly strong pump to withstand the severe strains put upon it by this service. For boiler feeding and general service it has also been very successful, and is made in a number of sizes to suit all requirements.

As will be gathered from the above particulars, the exhibit of Messrs. Clarke, Chapman & Co. was one of the most complete and important. It showed the wide range covered by the power machines made by this well-known Tyneside firm.

Automatic Railway Coupling.

Coles Universal Automatic Buffer Coupler Company, Chester-le-Street, Durham.

MODELS were shown illustrating a new automatic buffer coupler which would appear to be particularly effective in practice. There have been many attempts made to devise an automatic means of coupling railway vehicles; some of these are already in considerable use, particularly on electric railways, but they are more or less elaborate and expensive; they are sufficient to meet the requirements of passenger train service where the make-up of a train is not frequently altered, but for goods service—where shunting and coupling are ceaseless and where the roughest conditions exist, and, moreover, where the necessity of automatic coupling for the prevention of personal accident and increased speed of work are most desirable—such automatic couplers have

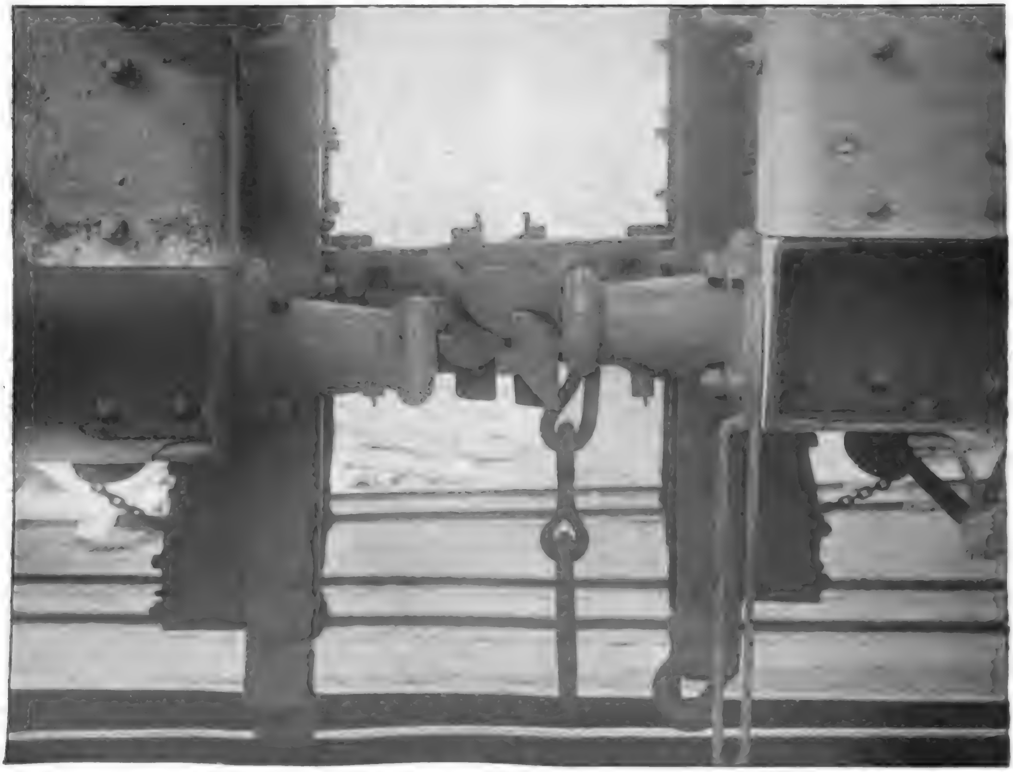


FIG. 1. THE COLES AUTOMATIC COUPLER APPLIED TO COAL WAGONS.

not been considered satisfactory either in operation or cost.

Reference to the illustrations herewith shows the simplicity of the Coles coupler. Each side is merely a strong one-piece forged draw-bar, the coupler head of which has a double Veed face ensuring self-centring and a correct locking of the couplings. The coupler has side buffer springs and is thus free for sufficient horizontal or vertical displacement to permit of perfect action on any railway curve or with any practical difference in the draw-bar heights of adjacent vehicles. The couplings are locked by a strong hook or catch which engages with a side block forming part of the opposing main coupler forging. It is here that the only wear is liable and the engaging faces of the hook and block are fitted with hard steel faces which are, however, easily accessible and can be renewed quickly at small cost and without dismantling the coupler. The grip obtained is apparently perfect and reliable; no amount of vibration or jolting can release the coupler. The uncoupling is effected by means of a chain leading from underneath the coupler over a sheave under the wagon, and connected to a hand lever at the side of the wagon. The levers are thus at opposite corners of the wagon; any lever releases both sides of the coupling and the latter resets itself for further automatic coupling. The releasing lever can be fastened by a pin in the off-position so that the coupler merely serves as a buffer for fly shunting, etc.

The more important claims of the makers for this simple and effective device, which is well worth the careful attention of all railway engineers, are: In actual practice the full-sized couplers are found to work as smoothly and accurately as the model; all the Board of Trade requirements are met; it is simple and inexpensive; the parts liable to wear are easily replaced, without dismantling the whole coupler; the cost of replacing these parts is exceedingly low; it couples vehicles of different heights at draw-bar, *i.e.*, light and loaded; the action is

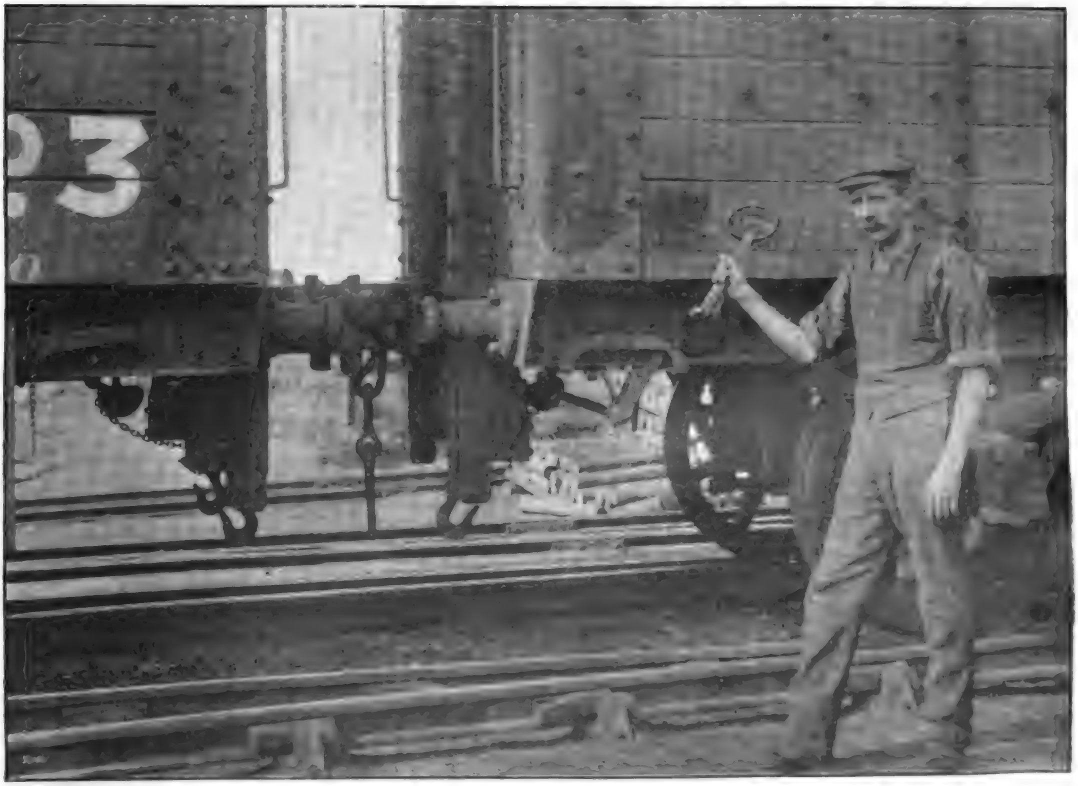


FIG 2. THE COLES AUTOMATIC COUPLER, SHOWING THE RELEASING LEVER.

not affected by the acuteness of a curve, light and loaded 20-ton wagons having been coupled on a curve with a radius of 128ft., or less than two chains; it can be readily released on either side of the train, the operation is easy and safe; it is certain in action and cannot possibly uncouple of itself; no alteration is required to construction of trucks; an engine fitted with this coupler can pick up a runaway wagon; it is a centre buffer coupler, and the two side buffers can be dispensed with; it is automatic and admirably adapted for rough or fly shunting, in which operation the coupler is rendered non-coupling by a very simple and effective device; it is quite easy to slip a carriage or wagon from engine or van; There is an enormous saving of time, it being possible to couple a whole train at once.

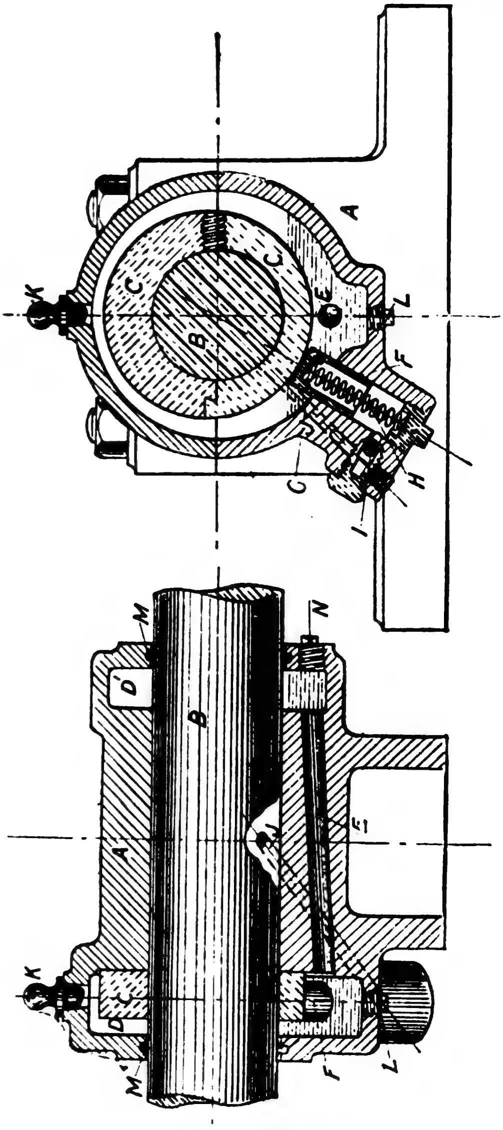
Automatic Forced Lubrication.

The Forced Lubrication Company, Ltd., Manchester.

THE excessive wear and tear caused through inefficient lubrication necessitates constant renewals. This applies to every type of bearing, especially rolling stock. The rattle and discomfort of travelling is caused through inefficient lubrication, and if a good system be adopted the life of all rolling stock and bearings generally would be considerably increased. The value of forced lubrication has been amply demonstrated to be far superior to any other system of lubrication. Where a single pump is used to supply a number of bearings the amount of oil reaching any given point obviously depends upon the resistance of the passage to that point from the pump. The bearing having the longest pipe, the most bends or faulty connections, will not get its proper quantity of oil, if any; and providing everything be perfect, the oil in such a system must be led in at the point of minimum pressure.

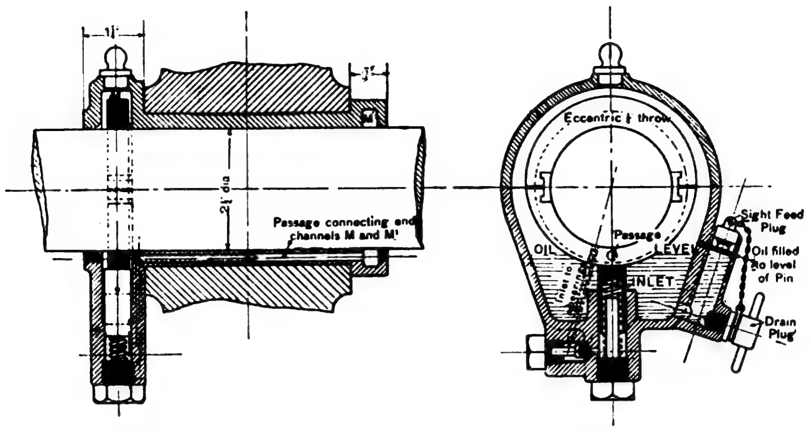
The best system results when each bearing has its own pump, when outside connections are dispensed with, and when the oil is led in at the point of maximum pressure. This is the case with the Tilston's patent automatic forced lubrication system, which was exhibited in operation on a shaft, running at 400r.p.m., the two swivel bearings of which were fitted with the appliance and pressure gauges applied to show the distribution and pressure of the oil.

The nature of the device will be readily gathered from the accompanying sections.



FIGS. 1 AND 2. SECTIONS SHOWING ARRANGEMENT OF BEARING FITTED WITH PATENT AUTOMATIC FORCED LUBRICATION SYSTEM.

Figs. 1 and 2 show the arrangement as adapted to replace worn-out brass bushes with a bush in which the forced lubrication system is self-contained. They also show the simplicity of its application to existing bearings.



FIGS. 3 AND 4. ALTERNATIVE ARRANGEMENT OF FORCED LUBRICATION SYSTEM FITTED TO BEARING.

The shaft B carries the eccentric C, which may be either keyed or set screwed to the shaft, and can be made in halves as shown. D and D¹ are the end chambers to collect oil from the bearing; the passage E connecting the end chambers together. F is the pump plunger or thimble, made from steel tubing forced on to a solid end; G being the inlet holes in the plunger for the oil to pass inside the pump. The spring H serves to keep the plunger against the eccentric. I is the non-return ball valve of the pump, whilst J is the outlet from the pump to the shaft.

Sufficient oil is poured through the oil-feed K to last several months, and is continually forced through the frictional parts of the bearing and then returned to the oil chambers D and D¹ to be forced through over and over again.

The pump-plunger or thimble F is reciprocated by the rotation of the eccentric C. When the plunger F is at the top of its stroke, the oil in the end chamber D escapes through the inlet holes G inside the pump. As the plunger descends the inlet holes G are cut off by the casting, and thus the oil is forced past the non-return valve I and through the outlet J to shaft to be lubricated.

The particular advantages claimed by the makers are: Considerable saving in oil; minimum or no wear; brass or white metal bushes are not required, and consequently no renewals; no attention to fill oil or grease cups—a filling of oil will last from three to six months with this system; no overheating and consequent stoppage; the oil is not whisked about and made frothy as in ring oiling bearings; absence of friction, thus reducing the coal bill considerably; simple and positive in action, &c.

The automatic forced lubrication system is applicable to every type of bearing. To enable manufacturers to fit the system readily the makers have standardized all the pump parts, eccentrics, drain and sight-feed plugs. The standard set of five pump parts is sold to the licensee at 1s. per set and the royalty charge is 1s. per inch in diameter of shaft.

Cutting and Welding by Oxy-Acetylene Blow-Flame.

A. Warden & Co., London, E.C.

FOR the cutting and welding of metals this firm showed an interesting adaptation of the oxy-acetylene blow-pipe. Ordinary acetylene gas from calcium carbide with a jet of compressed oxygen is applied to the cutting of iron bars and the welding and perforation of plates, &c. It is claimed that a 2in. iron bar can be cut through in three minutes with a cut not exceeding ⅛in. to $\frac{3}{16}$in. wide. It will be seen that this process is capable of being applied with success to many special purposes in the repair and alteration of metal parts.

Electrical Contractors' Work.

F. A. Glover & Co., Ltd., London, E.C.

THE electrical fitting work of the Exhibition was placed in the hands of Messrs. F. A. Glover & Co., Ltd., who have had considerable experience of this class of work, they being the official electricians of the Agricultural Hall Company. The great feature of the electrical part of exhibition equipment is the great amount of duplicate work to be done in a short time. In this case within ten days Messrs. Glover fixed over 1000 lights for some 120 to 130 stands, fixed about 100 motors ranging in size from ½h.p. to 35h.p., about 30 arc lamps, and supplied and fixed upwards of 100 supply meters, and C.I. enclosed-type main switches and fuse-boards. This work is not very straightforward either; exhibitors require the wiring, and often the motors, to be stowed away inconspicuously, some want switches all over the stand, others have motors right overhead, and again they are hidden under benches or machines: and with it all there was the rigid censorship of Mr. Albion T. Snell, the consulting engineer of the Exhibition, to be met. It is highly creditable to Messrs. Glover that in no case was any part of their work officially condemned or taken exception to.

"Dey" Time Register.

Howard Bros., London, E.C.

THE "Dey" time register consists essentially of two separate operative sections. The first is the timepiece or clock, and the other the mechanism for recording the time it is desired to register. The clock used on these registers is of the kind known as the English fusee clock, well known as a first-rate time-keeper. The general external view of the register given below shows the working principle in some detail. There is no occasion to describe the clock. The actual mechanism by means of which the times when the workmen enter or leave the works are recorded is the novelty of the apparatus. It will be seen that, attached to the centre spindle which carries the minute hand of the clock, is the minute type wheel, the connection between it and the clock being a system of jointed levers, which allows movement of the type carriage to or from the clock, and also allows the small vertical motion necessary to bring the type-wheels down on the drum. By

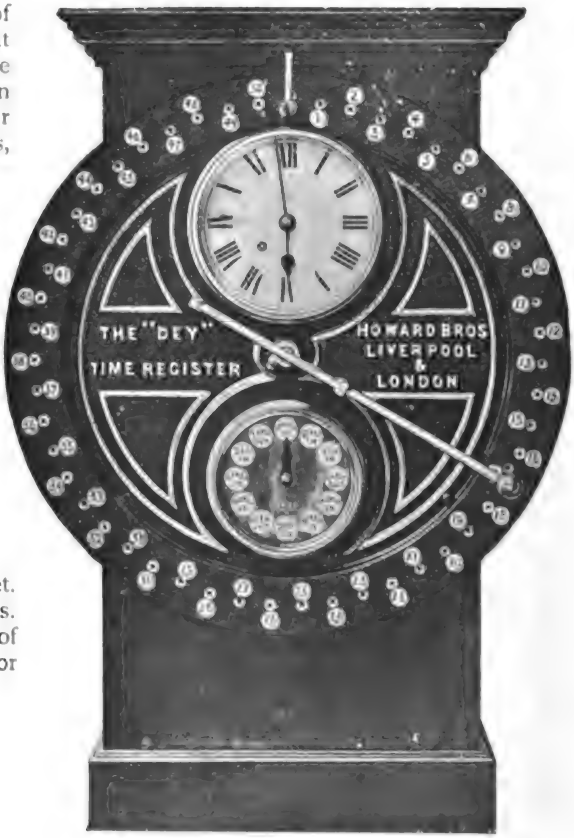


FIG. 1. GENERAL VIEW OF THE "DEY" TIME REGISTER.

means of this arrangement the minute type-wheel always remains in unison with the centre pinion of the clock, and revolves once in each hour. On the periphery of the minute type wheel, are raised numbers from 1 to 59. The wheel only records minutes, and being in constant motion, it is clear that the type cannot be in the correct position for printing between each minute. To obviate this disadvantage an ingenious arrangement has been devised in the shape of a steel knife-wheel, which is attached to the minute type-wheel. This knife-wheel

has sixty slots, milled in the circumference, and into these slots a pivoted knife descends just before the type on the rim of the wheel in its downward movement reaches the paper on the drum, thus bringing the type-wheel into its nearest exact position, and holding it steady for printing.

The hours are printed by the hour type-wheel. This wheel has the numbers 1 to 12, and it is provided with a star wheel having twelve teeth. A pin in the minute type-wheel engages with the teeth of the star wheel and produces a step-by-step rotation; that is to say, one step (representing an hour) is made to each revolution of the minute-wheel.

Up to this point all the "Dey" registers are alike in construction—namely, a time-piece with type-wheels connected to it in such a manner as to allow separate motions to and from the clock, but compelling exact rotary motion with the clock, so far as recording the correct time is concerned. It is at this stage that requirements vary.

The first variation depends on the number of people requiring to register their comings and goings on the machine. A firm, or a department of a firm, employing, say, one hundred hands or less is accommodated with a No. 2 machine, on the front plate of which is a circle of one hundred holes, numbered as required. An arm terminating in a knob and pointer is pivoted concentric with this circle of holes, so as to allow the pin to enter each of the holes as required, when the lever is pressed towards the face plate. Thus the operation of registering consists of taking hold of the knob, turning the lever round until the knob is opposite the right hole, and then pressing the pointer into the hole. A gong is arranged to strike during registration, to assure correct pressure being applied to the knob. This action of forcing the lever towards the face of the dial presses a rod that passes through the shaft carrying the drum, and moves a lever which is connected by suitable mechanism to the carriage, which latter, along with the type-wheel, it pulls down against the paper on the drum. The moment the lever is released the carriage is, by means of a spring, drawn up again from the paper, ready for the next movement of the lever. The drum revolves with the pointer arm, bringing the corresponding number on the time-sheet (on the drum) under the recording mechanism. The same description applies equally to the larger machines, which are made to register up to two hundred hands.

If no further provision were made a fresh slip of paper would be required for each registration, which would be inconvenient. The longitudinal motion of the type carriage is therefore now brought into operation. This carriage is mounted on a screw of such a pitch that one revolution equals the width occupied by a column of print on the paper carried by the drum. One revolution of the screw thus brings the type into position for another registration, and this can be continued up to as many as forty-two columns, thus providing for registering six times a day for seven days without renewing the paper slip. The revolution of the type carriage screw is done either by the handle or automatically. The handle is pivoted on the screw, so that it can be turned up when not in use.

The time-sheet is placed on the drum by simply raising a rod out of the slot in the drum, and fixing each end of the sheet in the slot by letting the rod, which is attached by two springs, slip back into position.

The lower of the two small dials on the main dial has its circumference divided into twelve different parts, which are lettered to correspond to different events of the day, as, for instance, "Morning in," "Dinner out," &c., and a pointer is provided which indicates at once the position of the type-wheel and the carriage, for when the screw is turned by the handle, its motion is not only transmitted to the carriage, but also to the spindles, and through them to the pointer on the dial just referred to. It will be seen from this that the type on the wheel marks the paper on the drum at any point on a line parallel to the axis of the drum, according to the position of the pointer on the dial.

Two reels, which carry the inking ribbon, are so arranged that when the whole of the ribbon is wound from one to the other, they reverse automatically, which action is repeated each time the ribbon is completely unwound, until the ribbon is worn out. The whole machine may be put out of action by pulling a lever at the back of the machine to one side, which allows the spindle that passes through the drum shaft to move without its motion being transmitted to the recording mechanism of the machine, and consequently leaves the type carriage unaffected.

For employers requiring to register the time occupied by workmen on particular jobs, a card attachment can be added to the machine. For this attachment an opening is provided in the left-hand door into which a card can be inserted at the time the job is commenced and again when it is completed, thus registering the time occupied. This does not in any way interfere with the regular use of the machine at fixed periods, as before described.

"Automatic Cashier."

British Coin Handling Machine Co., Ltd.

An ingenious machine which attracted a good deal of attention was the "Automatic Cashier," by which wages, &c., are counted out with remarkable speed and unerring accuracy. It will be seen from the illustration below that this machine has rather the form of a typewriter, having press keys corresponding to money values. Any sum ranging from several pounds down to 1d. can be brought into the receiving tray by the simple pressing of one or two keys. Worked in conjunction with a coin-sorting machine the labour saved in a large works by the use of this new appliance is very considerable. It is stated that at the works of Messrs. Ludwig Loewe wages for some 2500 hands are put up in two hours. The machine itself is highly perfected in its design; the supply of coins is always in sight; when the supply of any particular coin fails

The "Automatic Cashier."

the corresponding key or keys are locked; the tray or rack which carries the coins can be removed from the machine and readily transferred to the safe. Several attachments for receiving amounts fed from the machine are available, thus the amounts may be gathered into an ordinary tray, or by means of a shoot they may be guided into the small tins or envelopes so frequently used in this country for distributing wages. Whilst this machine is comparatively new to this country, it is stated to have been largely taken up on the Continent. There can be no doubt that the publicity which the device has obtained at the Exhibition will be the means of its adoption by many of our large manufacturing concerns.

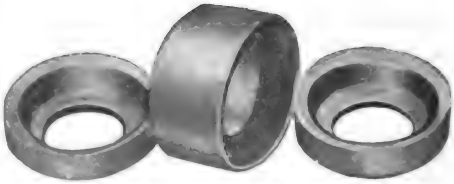
Another interesting speciality of this firm is the "Protectograph," by which cheques are stamped or perforated with a printed inscription giving the limit of value.

Dexine Packings.

The Dexine Patent Packing and Rubber Company, Ltd., Stratford, E.

A large and varied assortment of joint-rings, packings, &c., of Dexine composition were shown. This composition is widely used to take the place of ordinary india-rubber and leather for goods as used for engineering purposes, such as pump buckets, hat and cup rings.

In the form of steam jointing and man-hole rings, it withstands superheated steam to 700deg. Fahr., and resists the action of heated oils. Dexine boiler-feed pump buckets are now largely taking the place of gun-metal pistons and vulcanite rings.



Dexine Packing Rings.

Dexine, in the form of conical gauge glass and valve spindle packing rings, has been found a most satisfactory material for this purpose; it is said that they are being turned out at the rate of 10,000 per day.

Heating apparatus and hot-water pipe joints form quite a speciality; valves, sheeting, strip, tap washers, socket rings, bottling

cups and cones, and every description of mechanical rubber goods are made in Dexine, and are coming into wide use because of their great durability and low cost.

Fig. 2. Bank of Boilers fitted with Hotchkiss Circulators.

Circulators and Steam Traps.

Arthur Ross, Hotchkiss, & Co., Ltd., London, S.E.

SOME particulars of this interesting exhibit were included in the last issue of THE ELECTRICAL MAGAZINE. The illustrations show the general construction and principle of the Hotchkiss circulator and the "Patros" steam trap. The circulator, shown in Fig. 1, as adapted to a Lancashire type boiler, maintains a thorough and rapid circulation of water inside the boiler, and at the same time provides a ready means of arresting any suspended solid matter or deposit. Its action is self-evident from the sectional illustration Fig. 1. Fig. 2 is a general view of a bank of boilers fitted with these circulators.

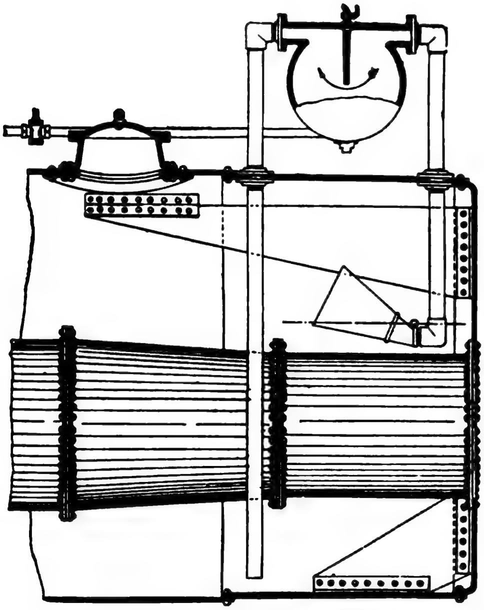


Fig. 1. Section of Lancashire Boiler showing Hotchkiss Circulator.

The effective action of this circulator was shown on the exhibition stand by means of glass boilers and circulators. The function of the circulator as an automatic collector of scum and deposit was also seen to good advantage.

The "Patros" steam trap shown in section in Fig. 3 is a new introduction of the company which is stated to combine the advantages of the expansion and float types of trap in one. The special features claimed by the makers are: it will work through a large range of pressure without dribbling; it is an expansion trap, but discharges periodically; the steam pressure is under the valve, keeping it closed; the discharge water is cool, hence wear of the valve is the minimum; the trap can be hand-tested at any moment.

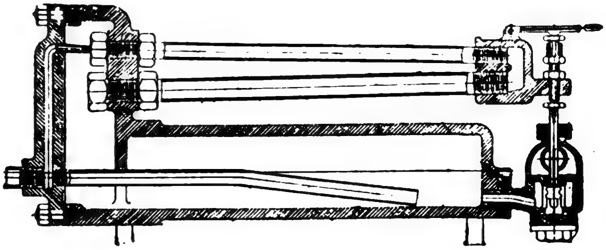


Fig. 3. Section of the "Patros" Steam Trap.

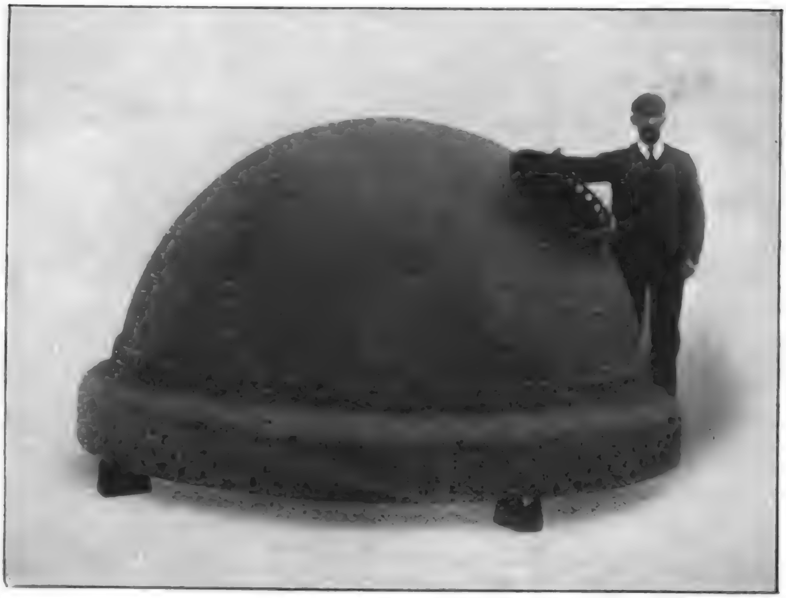


FIG. 1. ONE-PIECE FIRE DOME OF COCHRAN BOILER.

Vertical Boilers.

Cochran & Co., Ltd., Annan.

SEVERAL interesting particulars of the special uses to which the Cochran vertical multi-tubular boiler has been applied were given in THE ELECTRICAL MAGAZINE of last month. The illustrations now given show very clearly the general design of the boiler. It will be seen that the arrangement adopted is essentially compact and yet that the tubes, smoke-box and furnace are very readily accessible. The fire-box dome or furnace formed from one plate without weld or seam of any kind is shown in Fig. 1. The other illustrations show two modifications of the standard type of boiler complete. As said, these boilers have met with very considerable favour for portable steam plants, also where floor space is restricted and where steam-generating plant has been required in the out-of-the-way places of the world and difficulties of transport are met with.

The makers' claims—that the boiler is safe, simple, and convenient; that it can be easily cleaned and inspected, and, consequently, that it is a good

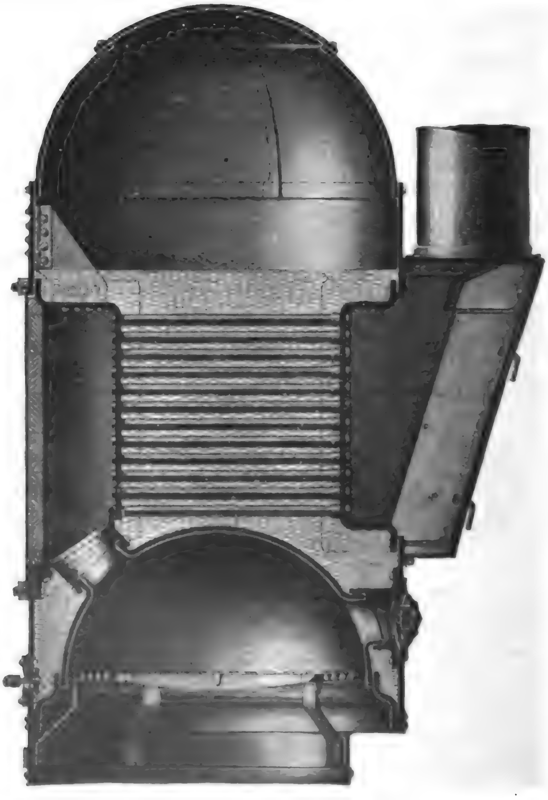


FIG. 2. SECTIONAL VIEW OF COCHRAN BOILER.

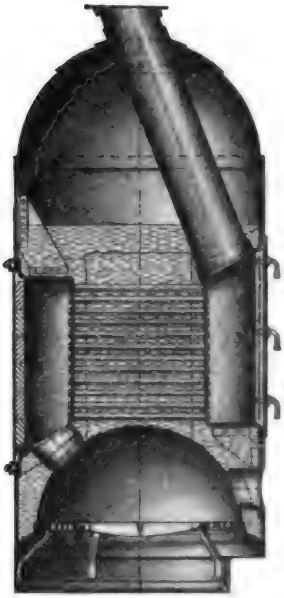


FIG. 3. SECTION OF COCHRAN BOILER.

steam raiser with any grade of fuel or bad water, are substantiated by a glance over the sectional illustrations Figs. 2 and 3.

Wire Ropes and Aerial Ropeways.

Bullivant & Co., Ltd., London, E.C.

MESSRS. BULLIVANT & CO., LTD., the well-known wire-rope makers, showed a large and varied exhibit of steel-wire ropes and many appliances used in connection therewith.

The various stages of the manufacture of wire rope from the iron ore to the finished article were shown. In the first stage, iron ore previous to smelting; in the second, iron ore in briquette form for shipment; in the third, pig iron smelted from ore; in the fourth, a fractured ingot partially planed to show solidity; in the fifth, a steel ingot after being compressed; and in the final stage the steel rods from which are drawn the fine wires for making up into rope.

In the centre of the stand were shown four large pyramids of special extra flexible and extra flexible steel-wire rope, both galvanized and ungalvanized, from 1in. to 4in. circumference. There were also exhibited purchase and non-purchase reels; a crab winch to lift 2½ tons direct from the barrel; a Bullivant's patent portable nipper for gripping a 2½in. circumference rope; a Bullivant's patent automatic nipper tested to 10 tons for gripping a 3in. circumference rope; 18in. sheave blocks, 1, 2, 3, and 4 fold, the latter tested to 68 tons; 12in. sheave blocks tested from 8½ up to 31½ tons; 16in. sheave snatch block tested to 16 tons; and a set of patent differential pulley blocks to lift 1, 2, and 3 tons.

In addition there were several show cases containing samples of wire ropes of all makes and sizes; one, a particularly interesting case, containing a sample of a rope 5¼in. circumference, having a guaranteed breaking strain of 100 tons, and five samples cut from the rope after it had been in use for nearly three years and had run no less than 80,171 miles. The five samples cut from this rope took the following breaking strains when tested:

		TONS.	CWTS.
Sample	1	78	8
,,	2	75	7
,,	3	74	6
,,	4	76	6
,,	5	75	14

Messrs. Bullivant & Co., Ltd., are the inventors of flexible steel-wire rope, which they first introduced in 1874, and one of the cases contains a sample which was cut in that year from the first steel-wire hawser ever used on a ship—the *Lady Jocelyn*. This was a 4½in. hawser with a guaranteed breaking strain when new of 39 tons. It was in constant use eight years, and at the end of that time it took, when tested, a breaking strain of 45 tons.

A revolving show case displayed sixteen different forms of steel-wire rope of one size.

Aerial Ropeways.

Aerial ropeways are a speciality of this firm, and the photographs of the lines designed and constructed by them in various parts of the world were in many cases very striking. A working model demonstrated Bullivants' system of aerial ropeway for raising, lowering, and transporting heavy loads, the whole operation being performed at one and the same time. This type is specially suitable for bridge building, quarries, canal excavations, shipbuilding, &c.

Wire Rope Cutters.

Messrs. Bullivant also showed a new device for cutting wire ropes or chains (Selby's patent), specially suitable for collieries, rigging lofts, ship-yards, &c., and an adaptation of the same machine for cutting ropes under water. These machines require only one man to actuate them, and in the short space of a minute steel-wire ropes up to 9in. circumference can be cut.

FIG. 2. ARMATURE OF JOHNSON-LUNDELL MOTOR.

Direct-current Machines.

The Johnson-Lundell Electric Traction Company, Ltd., Southall.

SEVERAL examples at rest and in service were shown of the Johnson-Lundell patent laminated-type direct-current electric motor. This is a new departure in d.c. electric motor construction, the machines having an entirely laminated magnetic circuit built up of special steel stampings cast in a C.I. skeleton frame, and arranged in such a way that the magnetic path is absolutely free from any inequalities such as are usually caused from spongy castings, bolts, rivets, &c. The skeleton frame is at once the mechanical body proper, enclosing the field laminations and forming the basis of the supports. It is so designed as to form a crate for enclosing the magnetic field in such manner as to not increase the important diameters one iota beyond those of the field itself. Its two end sections are united by means of extension lugs, carried across the field laminations at unimportant sections of their circumference.

FIG. 1. GENERAL VIEW OF THE NEW LAMINATED-TYPE JOHNSON-LUNDELL MOTOR.

The pole pieces are built up of laminated steel. The stampings are bound between two end plates by means of a single rivet, which, passing through the laminations in a direction perpendicular to them, so little obstructs the magnetic path as to become a negligible quantity. The pole heads, so constructed, are brought into firm and intimate contact with the yoke by means of substantial screws, which pass through the yoke casing outside the yoke laminations, and are threaded into the pole head end plates also outside of its laminations. The field coils are form wound, carefully wrapped and pressed into the required shape, and then thoroughly impregnated with a high-grade insulating compound. They are

further insulated and protected from mechanical injury by suitably disposed layers of presspahn and wrappings of insulating tape, and are held immovably in their positions by the toe-pieces of the poles.

The armature is of the slotted drum type, with windings of the stretch coil type. These coils are firmly secured in their respective slots by means of wooden keys dovetailed throughout the length of the slot.

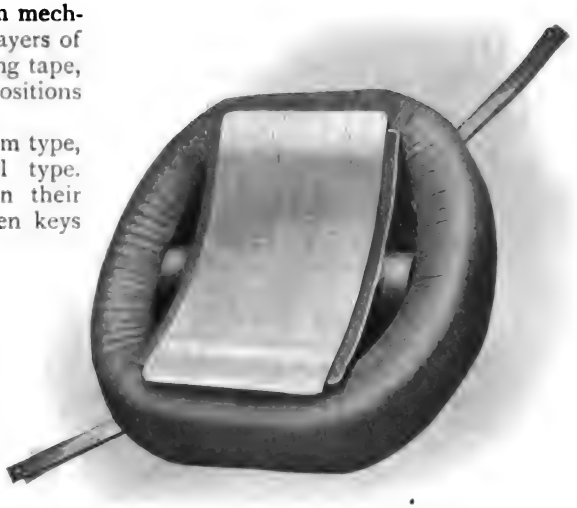


Fig. 4 Pole Piece and Field Coil of the Johnson-Lundell Motor.

The coil heads are so spaced as to afford an excellent air circulation, special provision for which is made in the design of the commutator spider and armature end plates. They are held rigidly in this position by being bound down with steel wire bands upon supporting rings cast upon the armature end plates for this purpose.

The commutator is built upon an open spider, the segments being of the usual hard-drawn copper insulated from each other by selected mica, and from the spider by moulded micanite rings; the assembled parts are then consolidated under hydraulic pressure.

These machines are also fitted with the Company's patent "Duplex" brush, which combines two carbons acting independently in one holder, yet assuming the form of a single brush upon the commutator. The carbon brush unit is thus sectionally divided and assumes the form of two semi-independent carbons arranged fore and aft in the direction of armature rotation. These move in independent slide ways at opposing angles, and are influenced by a self-balancing spring. They converge at a common point on the commutator and present thereto the same area of contact surface as would a single brush; the angle of pressure to which they are subjected causes each to effect good contact with both the central V-shaped wall of the holder and the face of the commutator. The holders are mounted upon a common rocker arm, thereby affording means for adjusting the brushes to the neutral position and for accommodating them to the commutator wear. The independence of the two sections of the brush effectively minimizes the destructive sparking incidental to slight commutator inequalities by rendering an actual break of brush contact possible only through the coincident throwing off of the two sections—a very unlikely occurrence.

Fig. 3. Frame of the Johnson-Lundell Motor.

The two functions of a

commutator brush—collecting the current and minimizing the commutating arc—are inherently antagonistic; the one demands a contact of low resistance, the other a contact of high resistance. All efforts to combine in one brush materials having these opposing qualities have been frustrated by the inevitable inequality of wear. In this case for the current-collecting brush there is employed a fine quality of soft carbon possessing the essential current-carrying capacity, and for the commutating brush a harder quality affording the high-contact resistance essential to minimizing the arc consequent upon the momentary short-circuiting of two commutating segments. An unequal wear of these brushes ceases to be of consequence in view of their practical independence.

The advantages claimed for these machines, chiefly due to the above improved methods of construction, are:—

Overall dimensions and weight for a given rated output less than any other machine at present made; sparkless commutation at all conditions of load up to 50 per cent. overload with fixed brush position; wide adjustment of speed by shunt control, and this of standardised range in the ratio of 1 to 3, without the use of interpoles; exceptionally high efficiency.

The Johnson-Lundell Company also exhibited examples of a new design of polyphase-motors. These motors possess the same features as regards small dimensions and light weight as the laminated type direct-current machines, and are fitted with ball bearings. Another feature in the design of these motors is that the end brackets may be removed for inspection purposes without disturbing the ball bearings.

Arc Lamps.

The Foster Arc Lamp and Engineering Co., Ltd., London, S.W.

THE stand exhibiting the motors of the Johnson Lundell Traction Company served to exhibit a large number of Foster arc lamps in actual service, the stand having probably the most brilliant lighting of any in the Exhibition. Besides their well-known ordinary types of direct and alternating current lamps, Messrs. Foster made a good show of a new flame lamp, Figs. 1 and 2, for which they have been receiving large orders from railway companies and Borough Councils.

The lamp is of very simple construction, with self-contained automatic cut-outs and substitutional resistances, and the use of clockwork mechanism is entirely avoided.

FIG. 1. FOSTER FLAME ARC LAMP.

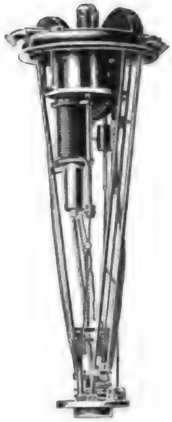


FIG. 2. LAMP INTERIOR.

They also exhibited a twin carbon flame lamp, which has the advantages of being much shorter in length, long burning hours, and is particularly suitable for use where ceilings are low.

A special feature of the exhibit was a new magazine flame lamp of reliable and simple construction for use with yellow or white flame carbons, necessitating only one trim in about sixty hours. The advantages of such a lamp, when the cost of flame carbons is taken into consideration, must appeal to our readers, the price of the carbons used being about one-sixth that of metal-cored flame carbons.

FIG. 3. FOSTER TRANSFORMER.

Other types of arc lamps included the Foster patent enclosed arcs and the now familiar miniature arcs which have lately come into much favour for interior lighting.

Foster & Co. are also making small transformers up to five kilowatts capacity, and are specially equipped for manufacturing these transformers to suit any conditions.

Fig. 1. Showing Repair by Castolin at A.

Castolin.

Wassermann & Co., London, E.C.

THE last issue of THE ELECTRICAL MAGAZINE contained particulars of this new material and its method of use for the brazing of fractures in cast iron. The claim of the inventors as to the remarkable strength of the joints made is substantiated by reports from many users. Messrs. James Archdale & Co., Ltd., Birmingham, the well-known makers of machine tools, found that a wheel broken in parts and mended with Castolin was stronger than the original casting. In their report they say, "To test its strength the wheel was again broken, and we found that the metal itself broke, but not the part previously brazed." At the Birmingham Rim Works, experiments were carried out on two lathe-racks, one of which had seven teeth, the other four teeth, broken out. These teeth were brazed in and afterwards shaped in the shaping machine. Both racks have been working since 19th February, 1907, and Mr. James, the principal of the Rim Works, writes: "It is very evident that these racks are now stronger at the brazing than at any other part."

With careful workmanship and by carrying out the instructions given by the makers it is found that cast iron brazed by Castolin has given tensile breaking strains of 9½ tons per square inch. These results were obtained on the repair work carried out by users of Castolin, which is striking testimony as to its merits. The dimensions of the castings are not altered by the process, and where the edges have not been damaged it is difficult after polishing to detect the brazing.

Examples of the work done by this new material are shown in the illustrations on this and the following page. These speak for themselves as to the ready way in which the process can be applied to the perfect repair of awkward, unwieldy pieces, and where fractures have occurred at critical points in a machine part.

Messrs. Wassermann & Co. are the makers of Castolin, for whom Mr. T. W. Sheffield, A.M.I.Mech.E., A.M.Inst.E.E, has been appointed the general manager for this country and Canada, Mr. W. H. Lilienfeld being the agent for the London district.

Fig. 2. Typical Castolin Repair.

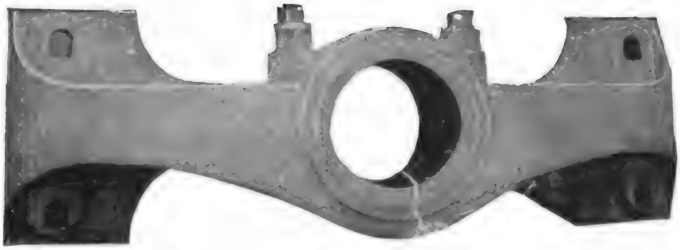


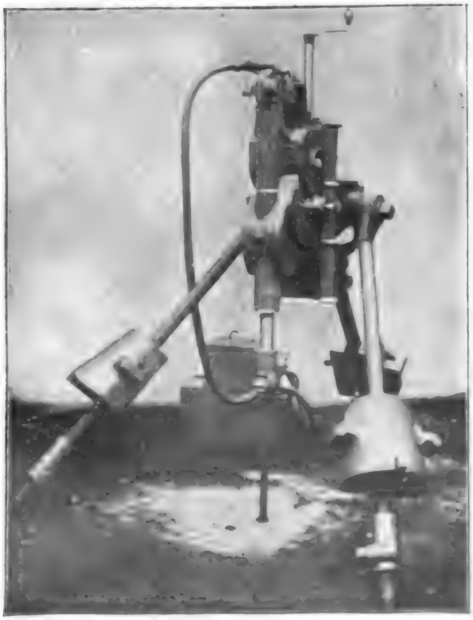
Fig. 3. Heavy Bearing Repaired by Castolin.

Petrol Rock Drill.

The Warsop Petrol Rock Drill Syndicate, Ltd., Chorley.

The illustration below shows a new form of rock drill in which petrol is the motive power; and taking into consideration the fact that such high powers are obtained for so little weight, in all cases where petrol is used, the great advantages presented by this over any machine at present employed for rock drilling will be readily seen.

One of the advantages claimed for this drill is its extreme portability, and this is at once apparent when compared with the compressed air plant and steam boiler, &c., as at present used. In these we have the weight of several tons, irrespective of the necessary water and coal, which has often to be conveyed considerable distances; but in the Warsop drill, the whole plant equipped with sufficient supplies for a month's work, the total weight would not exceed 15cwt.



The Warsop Petrol Rock Drill.

The initial cost of this new machine is a mere item when compared with the compressed air plant, but in working cost its position is certainly unique. All mining engineers are well acquainted with the great loss incurred in conveying compressed air from the power plant to the rock face, and the necessary pipe connections which are to be made every time the drill is moved; but in this machine, with its internal combustion engine within itself, we have at once one of the most economical powers known applied direct to the drill point.

To those acquainted with quarry work the adaptability of this drill is readily seen, and we should say there is undoubtedly a very large market open to this novel tool.

Improved Lever Lock.

The Margewood Lock Company, Ltd., London, W.C.

The Margewood lock is a British invention, and it is of wide interest to the general public, inasmuch as it is an improvement upon the mechanism of the world's lock—the lever—which is universally used for bankers' strong rooms, and for every commercial and domestic purpose, and is pronounced by authorities to be incomparable.

In the standard form of lever lock the bolt is solid only in so far as it engages with or protrudes from the lock-casing; that part which engages with the locking mechanism being reduced to a very considerable extent to allow room for the levers. The central portion of the lock and point of resistance to attack by force or skill in picking, the heart of the mechanism and essential part without which the lock could not be made, is the lever-stump, a pin of square section upon which the levers engage.

The lever-stump is fixed, generally by

riveting, to the thin interior or body of the bolt. It has only one bearing or support, and when forced, bent, worked out, or broken off, the whole of the mechanism collapses for all practical purposes. The bolt is also liable to over-shooting in consequence of its design.

The levers are pivoted on a pin which is riveted to the bottom of the lock-plate, and which generally has no second bearing or support for its top end. The pin so fixed may get out of position, or be forced, or the top lever, if the cap of the lock is not carefully fitted, may come off its pivot.

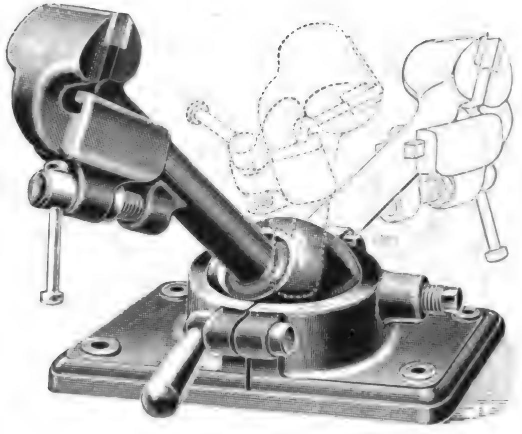
The Margewood lock has been devised to eliminate the above faults of the lever lock. The bolt and levers are combined, instead of being separate working parts, the levers being pivoted in the bolt, and the whole operating as one piece over a rigid lever-stump which takes a double bearing in the lock-case.

The particular advantages claimed for the Margewood lock are: the bolt cannot be forced without shearing the lever-stump from its double bearing, nor can it be overshot; the levers cannot get out of position; the lever-stump cannot be forced, bent, broken off, work loose, or get out of position; the difficulty of picking is increased; the strength of the lock is enormously increased; it is practically impossible for the parts to get out of order; changes of lever combination and general overhauling facilitated, as the whole of the mechanism can be taken out in one piece; the durability of the lock is increased owing to the simplicity and equal balance of the parts.

A Novel Vice.

Wadkin & Co., Leicester.

AMONG the smaller exhibits attention should be drawn to a new type of bench vice, which will at once appeal to engineers. The jaws are carried on the upper end of a column or arm, the lower end of which is fitted into the base with a ball-and-socket joint. Work once set in the vice can be twisted or set into the best position for filing, &c., and the ball joint rigidly clamped. The avoidance of constantly having to change the grip of a piece in the vice or working in uncomfortable and awkward positions is obviated by this useful introduction. Considering its principle, the vice is apparently very rigid, and will be found effective for all ordinary bench work.

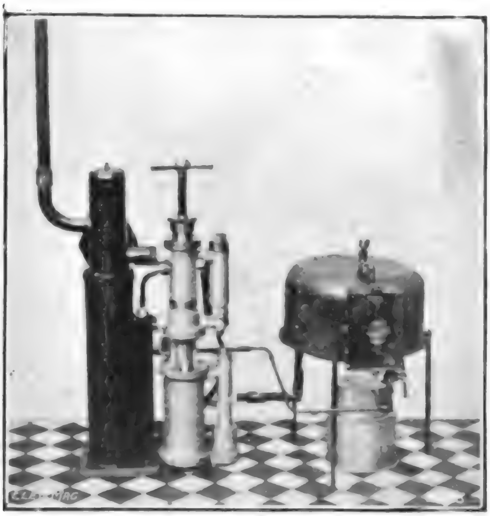


THE WADKIN VICE.

A Novel Automatic Pump.

The Lamp Pump Syndicate, Ltd., London, E.C.

THIS machine is a lift and force pump driven by steam at about atmospheric pressure, or at a higher pressure if necessary. The water from the well or tank is drawn through a tube, which is enclosed in an air-tight cast-iron vessel forming the base of the machine, and having on its upper end the valve-box of the main water valves. This cast-iron air-tight vessel is the condenser of the machine, and is fitted with a valve-box and suction pipe, used to extract the condensed water and air, and to maintain the vacuum in the condenser. The cylinder has an inlet pipe attached, through which is carried the exhaust steam from the cylinder. The pump barrel is of gun-metal, and is connected to the main water valve-box and to the condenser valve-box by flanges and bolts. The compensating chamber, which is placed alongside the pump barrel, has a loose piston within it, and contains an intake valve and a delivery valve, which delivery valve discharges all air, oil, and water drawn out of the condenser.



The duty of the loose piston in the compensating chamber is to arrange automatically the pressure differences in the pump barrel, both above and below the pump plunger. The pressure in the pump barrel below the plunger cannot become higher than the pressure above the plunger, as the free piston in the compensating chamber can rise and equalise the pressure above and below the plunger in the pump barrel; through this compensating action the pump plunger is always free to descend.

Provided that the difference between the source of steam and the condenser exceeds the pressure necessary to lift the control valve, the machine will attempt to overcome the head of water it is pumping against. The pressure that is required to do this is only one-fifth of its working pressure, which is normally one atmosphere.

The pump piston of the plunger type is actuated by a motor element consisting of a vertical control valve and its casing, a cylinder, piston rod, and piston of the plunger type. The ports are connected up by copper pipes.

The piston in the steam cylinder is raised by the pressure of the steam beneath it and the vacuum above it; when approaching the top of its stroke, a port leading to the base of the control valve casing is uncovered by the pistons and steam is admitted through this port to the underside of the control valve. The control valve is raised by this steam, a vacuum being maintained at its upper end, the up-stroke of the control being regulated by a dash-pot at its base. The raising of the control valve cuts off the steam supply from the boiler and places the ports leading to the top and bottom of the steam cylinder in communication, and at the same time cuts off the free passage to the condenser. The top and bottom of the steam cylinder being in direct communication, the piston, piston rod and pump plunger descend, the piston being in an equilibrium of pressure. The down-stroke is effected by the pressure acting on the upper surface of the pump plunger, which has the vacuum beneath it, and by gravity.

The control valve is kept up by the steam admitted beneath it, until the piston approaches the completion of its down-stroke, when a port is opened by the piston rod which permits of the escape of the steam to the condenser from the cylinder, and from beneath the control valve; the control valve then descends and admits steam to the under side of the piston, and at the same time opens a fresh passage from the upper portion of the cylinder to the condenser, and the action repeats.

To start the machine after steam has been raised it is only necessary to actuate the handle for a few strokes; this action pumps out any air or water from the condenser, and establishes a partial vacuum therein, and at the same time admits steam to the cylinder which heats the cylinder, and after a few strokes the actions are established for automatic continuance.

High Speed Drill; Electric Boring Mill.

John Stirk & Sons, Halifax.

A GENERAL view of the Stirk high-speed drill is given in the illustration, Fig. 1. As will be seen, it is fitted with an electric motor, the drive being by Renolds' chain on the first motion shaft. The motor is of 15b.h.p., shunt-wound, and built by the Lancashire Dynamo and Motor Company. The drill is provided with eighteen speed changes, the gears being so proportioned that mistake in setting for any speed is impossible. The drill is capable of driving a 1in. hole through cast iron at the rate of 11.3in. per minute. The actual drill speed can be varied from 16r.p.m.. to 530r.p.m., and there are four positive quick-change feeds varying from 32 to 105 per inch. Other features of this

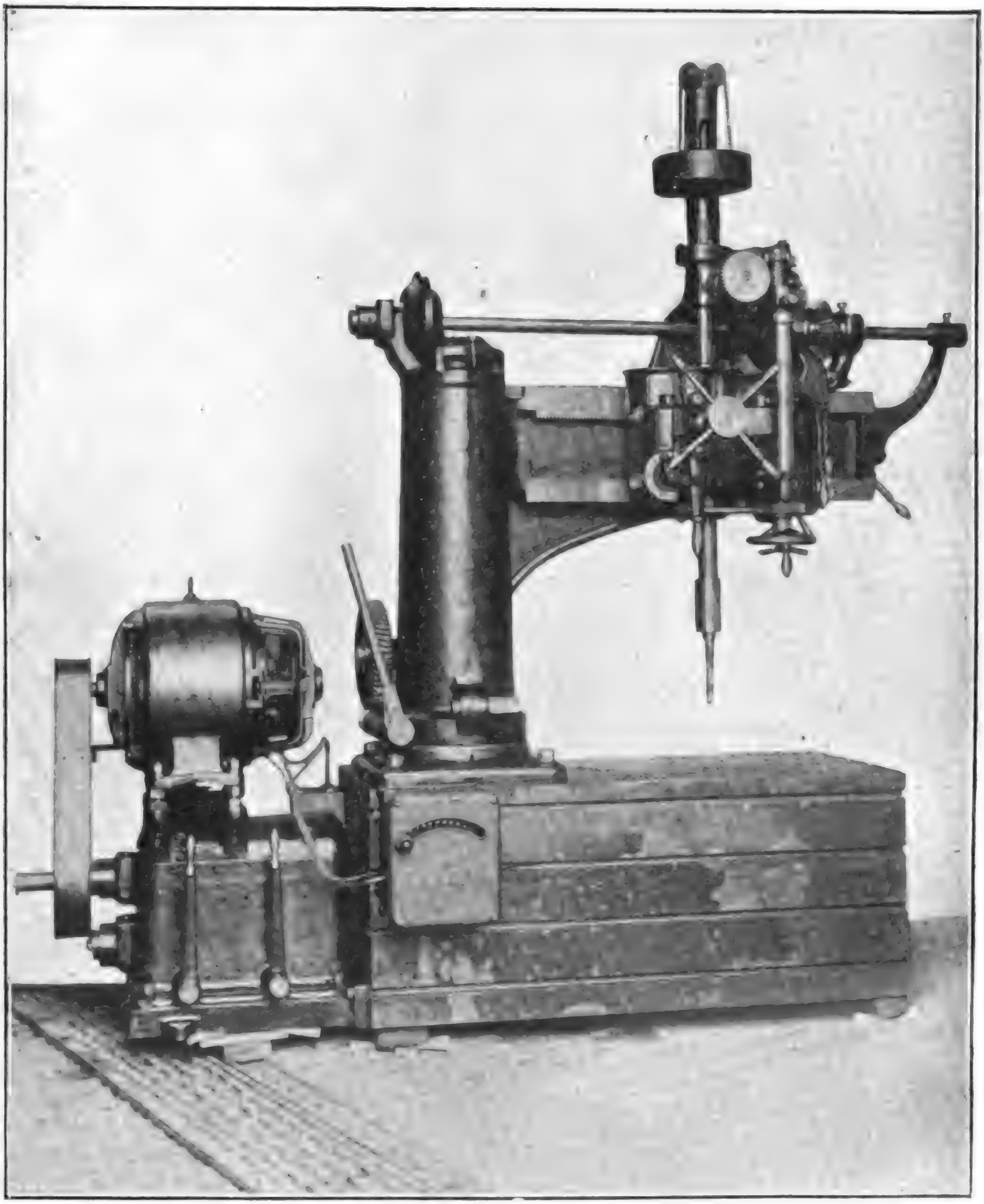


FIG. 1. THE STIRK ELECTRICALLY-DRIVEN HIGH-SPEED DRILL.

machine are that the spindle is balanced for tapping work; and, of exceptional interest, the patent reversing clutch motion of the spindle. This latter is an arrangement by which a friction cone is introduced between the two jaw clutches, serving to break the spindle rotation and reverse it before the positive jaw clutch is thrown in. As will be gathered from the illustration the machine is of well-balanced and massive proportions

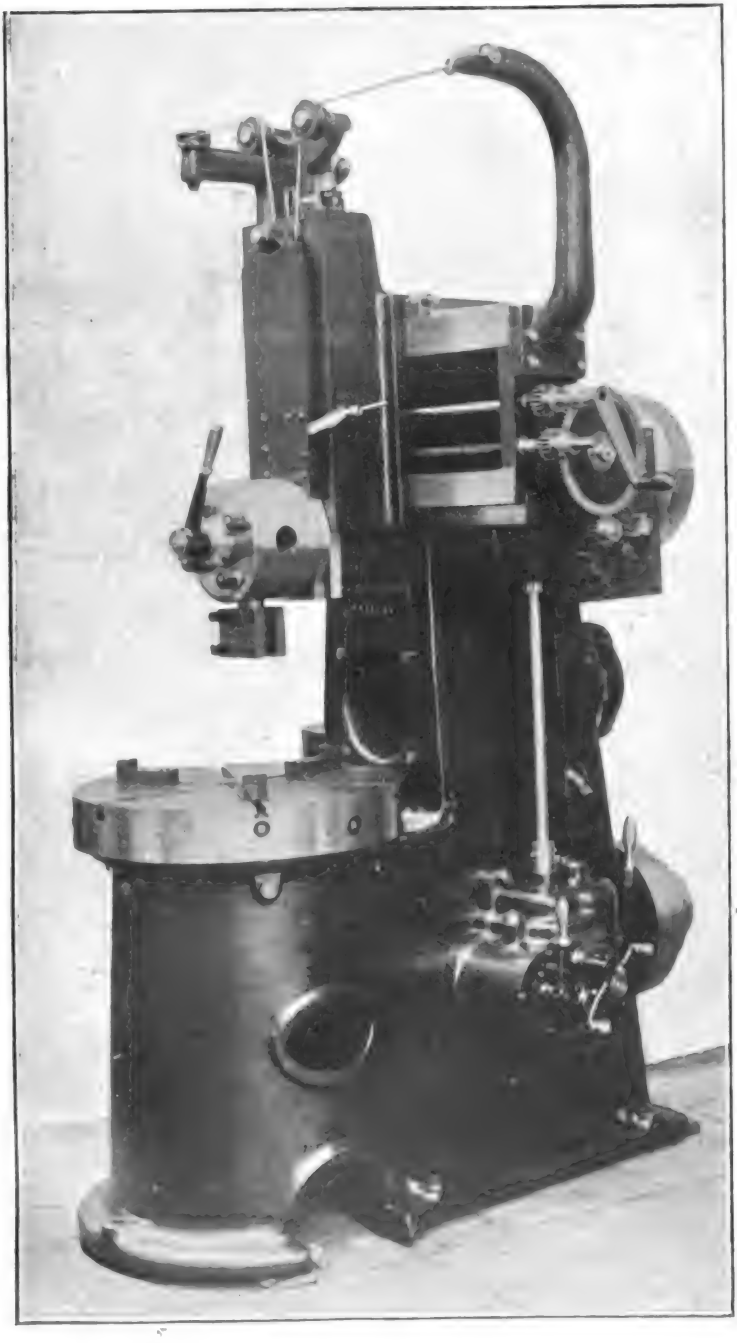


FIG. 2. THE STIRK ELECTRIC TURNING AND BORING MILL.

Electric Turning and Boring Mill.

Another machine exhibited by Messrs. Stirk and of particular interest to electrical men is the 30in. turning and boring mill illustrated in Fig. 2. This particular machine has a $2\frac{1}{2}$h.p. motor built into the main frame, the pole pieces being attached inside the standard. This form of construction is one which has been perfected by Messrs. Stirk, and has been adapted to the design of several other machine tools which they have turned out. The motor in this particular case is arranged for shunt-field regulation, by which speeds of from 800 r.p.m. to 1600r.p.m. are obtained, the rheostat used being of the Sturtevant type. In addition to this fine graduation of speed the machine is furnished with a pair of three-speed belt cones. The mill is fitted with a universal chuck-table, and has a capstan head for four tools. It is also provided with six-feed speeds and positive-feed reversing gear at all speeds.

As mentioned in the last issue of THE ELECTRICAL MAGAZINE, in connection with the notice of Messrs. Sanderson & Newbould's exhibit, Messrs. Stirk & Sons had a very fine high-speed electrically-driven lathe shown in use on Messrs. Sanderson & Newbould's stand. This machine was shown on very heavy service, being put down for the purpose of exhibiting to the full the cutting merits of the "SaBeN" high-speed steel.

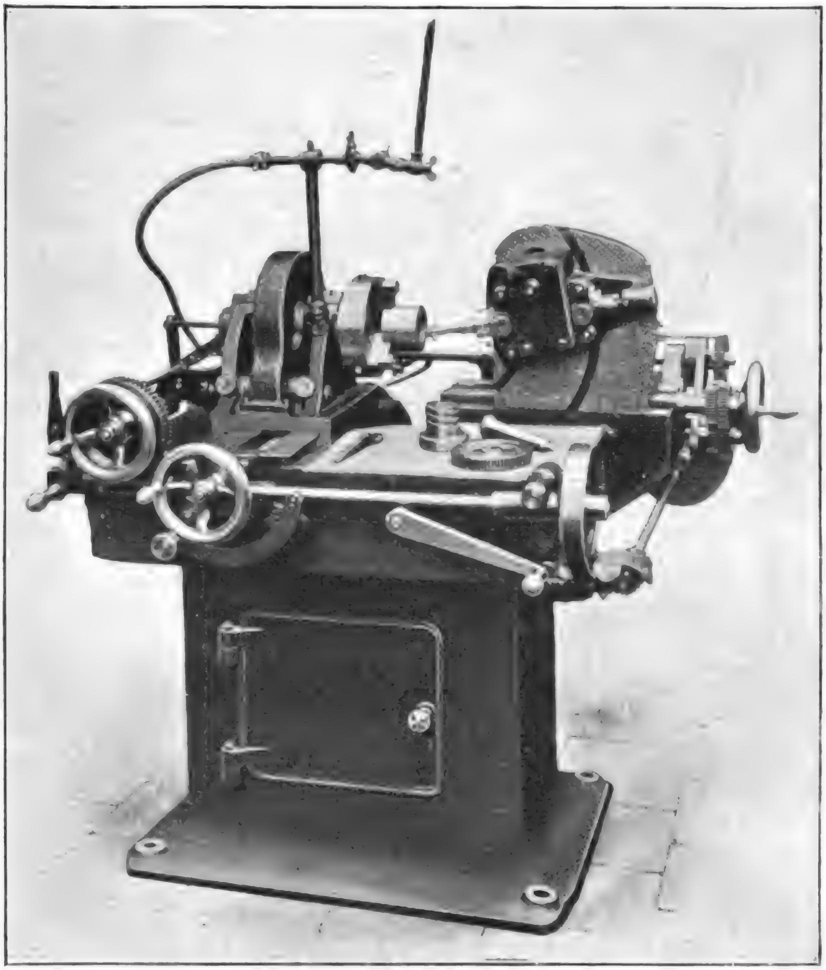


Fig. 1. The Holroyd Screw Milling Machine.

Screw Milling Machine; Electric Hack Saw.

John Holroyd & Co.

THE small machine for the milling of internal and external threads exhibited by Messrs. Holroyd proved itself to be a very speedy and efficient worker. As will be seen from the illustration, Fig. 1, the machine consists of a box pattern pedestal bed having two headstocks. The head carrying the work is fitted with a three-jaw universal chuck and has a fine micrometer feed with index plate for setting the depth of the thread being cut; it is further fitted with a quick withdraw, giving maximum speed for repetition work. The spindle of the cutter-head runs in parallel bearings, the end thrust being taken up by a hard steel tail-pin. The cutter mandrel fits into the spindle by taper and screw. The complete cutter-head, as shown in the above illustration, can be tilted or swivelled on the vertical face plate to give the required cutting angle for any thread, accurate setting being assured by a graduated index plate. The main drive of the machine is by way of the cutter head; this is by belt, through bevel gear and spur wheels on to worm, and thence through bevel and change wheels to the

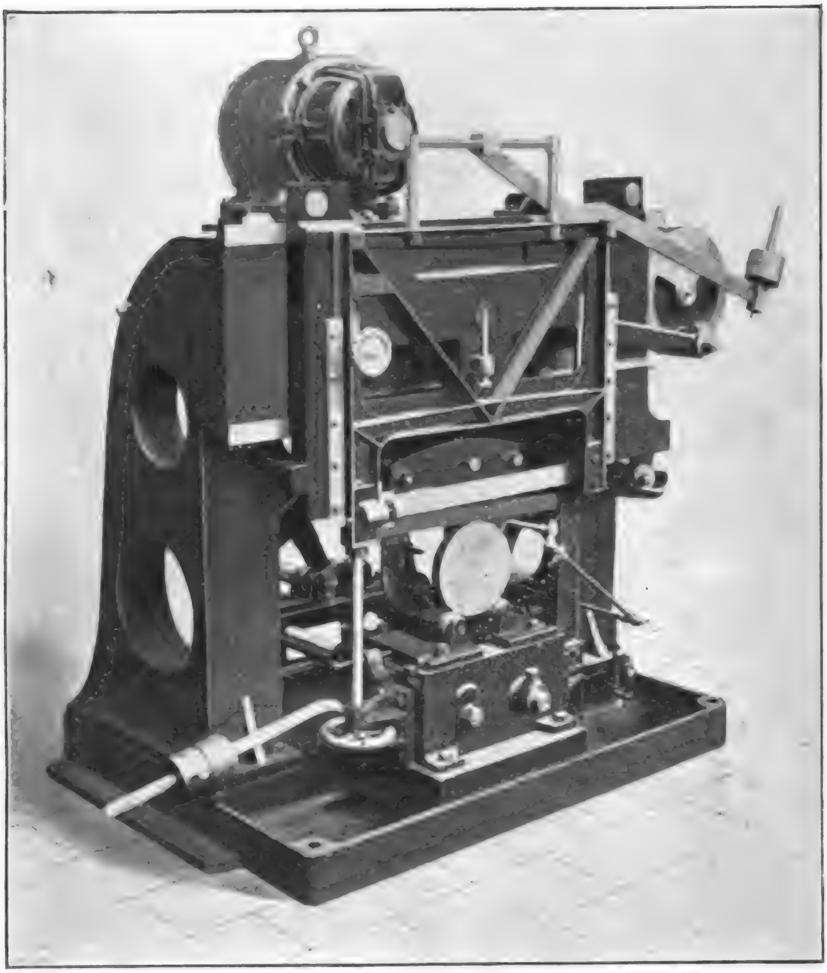


Fig. 2. The Holroyd Electrically Driven Hack Saw.

cutter. The worm gear is arranged for automatic sensitive knock-off.

The power connection between the cutter and work heads is by clutch actuated by the hand lever in the front of the machine. The machine is of a compact rigid design; all gears are machine cut from the solid, and the general care given to details gives a high-class finish throughout.

Electric Hack-Saw.

Another interesting tool shown by Messrs. John Holroyd was a 10in. hack-saw, self-contained, with a driving motor of $2\frac{1}{2}$h.p. The power transmission is by chain and spur wheels, the motor being mounted on top of the machine, as shown in the illustration, Fig. 2. The capacity of the saw is, for tubes and rods, from 5in. to 10in. diameter, and for beams up to 10in. by 6in. The saw blade is 23in. long, held in the frame by special grips; the work rests on rollers, and is held down by a top bar fixed in adjustable brackets. The work is rotated by an adjustable pawl motion, and for long bars being cut an adjustable stay is provided for holding up the projecting end.

[*We have been obliged to hold over descriptions of several meritorious exhibits. These will be dealt with in our next number.—Ed. E.M.*]

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

The Protection of Power Service Mains.

The Switchgear Company, Ltd., Birmingham.

THE extensive application of electricity to power purposes has opened up a field in which circuit-breakers can be used with great advantage for protecting power-service mains. So long as power work was mainly confined to traction, this method of protecting feeders was practically universal, but as electricity forced its way into general industrial power work, central lighting stations acquired a power load, and the local engineers have not yet, in many cases, abandoned the standard lighting equipment, namely, a double-pole fuse and a double-pole hand-operated switch, as their scheme of protection for power services. Thus a mixed system has grown up, each central station or power-supply company adopting its own method of protection of motor services. Again, plants installed by large industrial concerns, collieries, &c., which are in themselves little central stations, are now numerous, and have to apply some form of protection for their feeders and services. Diversity of practice has also been fostered by the increasing use of the alternating-current motor. Many of this type take a heavy excess current at starting, amounting in some cases to double the full-load working current. Fuses on such services cannot protect the motor efficiently, nor can circuit-breakers, if they are set at a sufficiently high current value to remain closed when the starting current passes.

The writer knows of one central station where circuit-breakers are employed for the a.c. motor services, and are set low enough to efficiently protect the motors. The type of motor in use requires a large excess current when starting up. The breakers used have fixed handles, and the practice is to permit the attendant when starting up to hold the breakers in. After the motor is properly started, and the starting switch put over to the running position, all is well, and the circuit-breakers act as an efficient protection to the motors.

This practice is open to the objection that the motor is unprotected at the time of starting up. It is also troublesome in attendance, but otherwise sound.

On general principles circuit-breakers form the best protection for service mains, but considerations such as the one just referred to and the ever-present consideration of £ s. d. has led to the retention of the simple double-pole switch and fuses in many instances.

Another reason for the lack of any recognised practice with regard to motor services is that there has been no standard form of appliance put on the market by manufacturers suitably designed to meet a wide range of requirement. The ordinary quick-acting circuit-breaker is not an ideal form of protection for service mains. As stated at the commencement of this article, the circuit-breaker has been adopted almost universally in traction work, and with satisfactory results, so that this may be regarded as standard and good practice. The case of general power distribution is, however, not quite parallel with that of traction. In a traction supply system most of the circuit-breakers are in

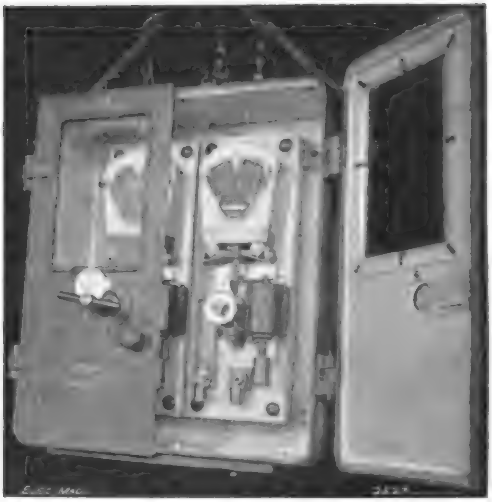
the central station or in sub-stations, and under the immediate eye and control of an attendant, or else they are in the cars themselves, also under control. Attendants, either in the station or on the cars, have time enough to attend to circuit-breakers, and replace them when required. Moreover, as tramcars are continually stopping in the course of their ordinary service, it does not seriously matter if an involuntary stop amounting to no more than a few seconds occurs. But in an industrial power supply, these conditions do not hold good. Interruptions to the power service are generally more or less serious—at the least they are annoying, and at the worst they may be both expensive and dangerous.

To take a particular case. The writer knows a paper mill where an interruption of the power supply costs the mill about £50. The drive is electrical, and circuit-breakers are installed as the means of protection to the power services. Interruptions have occurred at considerable cost to the mill, when, in all probability, the overload which caused the interruption would have gone off had the breaker been provided with some means of preventing its instant action. The case calls directly for time-lags, and, as a matter of fact, these are now being installed.

Many other instances could be cited to show that neither the quick action of automatic switches, nor the slower action of fuses, will meet the requirements of industrial motor services; but enough has been said to show that the circumstances demand a reliable automatic protecting device which will discriminate between short spurts of overload and those of dangerous magnitude, or of such a sustained character that, although not of great magnitude, they will injure the motor if not switched off after a suitable interval of time.

These essential features are supplied by the Statter patent time-lag, an instrument having a true inverse time element. A circuit-breaker or motor-starter provided with this attachment allows the motor to take double the current at starting, or even a little more if necessary. It allows the motor to take a moderate overload for a considerable period of time, but if this overload is persisted in, it ultimately switches it off. In the case of a dangerous overload, it switches off in a second or two, and in the case of a short circuit it switches off instantly. We have here then the one thing required to permit the adoption of automatic circuit-breakers for power services. Two circuit-breakers, one in each pole, and each provided with this form of time-lag, form an ideal protection for motor services for two-wire motors: three breakers are required for three-wire motors and so on.

Until recently, however, it has been impossible to obtain such an apparatus at a reasonable price, and it was not until the Switchgear Company went thoroughly into the question and produced a series of automatic service switches that the ideal power-service switch was placed on the market. Two years ago this company made their first



500AMP. SWITCH, WITH TIME-LAG ATTACHMENT.

sets of automatic power-service switches embodying the principle of the Statter patent time-lag, for the Chatham Dockyard. Since then, considerable numbers have been supplied for that Yard, also for the Portsmouth, Sheerness, and Malta Dockyards. These service switches range in capacity from 200 amperes to 1000 amperes.

The above illustration shows a 500-ampere standard-service switch.

It fulfils all the requirements that have been stated above to be necessary. It has also a shunt to which a recording ammeter can be attached and a full record taken over any desired period. This arrangement is effective and economical, since one portable recording instrument is enough for several

power services. A periodical record taken over several days for each service is sufficient for practical purposes. It may be repeated whenever there is reason to suspect that the conditions of any power service have changed.

The automatic switches in this power-service arrangement are operated from outside the cast-iron case by means of an insulated key. The switches cannot be held closed when a current exceeding that for which they are set is passing, nor can they be switched off slowly. Switching off is performed by reversing the direction of rotation of the key, but such reverse movement does not alter the position of the circuit-breaker brush until a certain angle has been passed through, when it trips a catch and opens the breaker at its maximum speed.

This form is made in all sizes from 200 amperes to 1000 amperes. Smaller sizes are in progress, and can now be supplied down to 100 amperes, and still smaller sizes are to follow shortly.

It is the aim of the Switchgear Company to produce a pair of automatic circuit-breakers in cast-iron case with shunt for recording, and with the time-lag principle and no-volt releases embodied, at a price that will enable them to be used on all industrial power services. As a matter of fact, it is now the most economical arrangement possible, because by its use the motor supplied is so thoroughly protected that it can be employed to do more work than motors protected by the commoner arrangements. Or, alternatively, a smaller motor can be installed for given work.

Not only is this arrangement safe, but it is financially desirable. It is uneconomical to use a motor which is not on the average worked near to its full load capacity. Until the introduction of the above appliance this could hardly be done with safety, and many motors are working at an average load far below the economical point, with disastrous results when considered from the standpoint of working cost.

In addition to the advantage obtained in working cost, the first cost is less. The service switch costs more, but the saving effected by using a smaller motor more than counterbalances this extra expense.

"Kalkos" Conduit System.

The Sun Electrical Company, Ltd., London.

THE are many features connected with the "Kalkos" tinned tube conduit system of wiring which will commend it to all engaged in the internal wiring of buildings. Whilst metallic conduits have been in vogue for this purpose for many years, and their use has practically become the standard practice for general wiring work, there has been much evidence that perfection had not been gained. From time to time improvements have been made in the conduits themselves: some have been welded and air-tight, others have been merely mechanical protections not claiming to be air-tight; there have been conduits lined with insulating material; again, some are arranged for screw connection; others simply have wedge jointings; and so on. All these modifications, each having its advocates, indicate that conduit systems as a rule do not perfectly meet all requirements. Sometimes the fault has been internal condensation of moisture in the conduit; in other cases unsightly work has been the objection; then again joints in conduits have not been sufficiently defined and rigid; in others the labour of installation and wastage has been excessive. To devise a conduit system which would overcome all these objections has been a problem for many years past, and it would seem that the Sun Electrical Company, Ltd., have very good reason to claim that they have at least advanced very near to the perfect system with their new "Kalkos" tinned tube conduit.

It is some years since Messrs. Hancock & Dykes, well known as consulting engineers, introduced into some of their work the use

FIG. 1. STANDARD SIZES OF "KALKOS" CONDUITS.

Fig. 2. Flush Switch Box Complete.

of brass tubing for wiring ducts. This method was prompted by the opinion that faults and troubles with conductors encased in steel or iron conduits were mostly due to the condensation of moisture or "sweating" inside the tube. It was thought that by using a thin walled tube of a better heat-conducting metal than iron, this condensation would be prevented, since the tube would then more quickly follow changes in the external temperature. The truth of this was fully exemplified with those installations where thin brass tubes were tried. It is stated that brass tubes have been used by Messrs. Hancock & Dykes for the past ten years for special high-class wiring installations, and that in those cases there has been practical immunity from breakdown of conductor insulations. The success of these pioneer installations led the Sun Electrical Company to introduce their "Kalkos" system. The conduits are of brass tube, tinned inside and out. The joints are made by slip-over sleeves which can be readily soldered, thus making an air-tight continuous brass duct. Special fittings have been designed for use in connection with these conduits, whereby the entire wiring system is practically maintained air-tight. The illustrations show several of the standard fittings. From these it will be seen that exceptional care has been given to their mechanical design. Take for example the surface

Fig. 3. Insulating Bush for Switch.

Fig. 4. Flush Cover with Ring to take Switch Plate.

switch-box shown complete in Fig. 2 and its several parts in Figs. 3 to 6. It will be noticed that the porcelain base of the switch proper is mounted on a metal threaded ring by which its height is positively adjusted. There are no threads moulded in the earthenware part of this switch, but all threads are well and accurately cut in metal. The method of assembling such a switch is shown in the sectional cut Fig. 7, which, although it shows a ceiling rose box, is practically assembled in an identical manner. This last illustration shows the way in which

Fig. 5. Adjustment Ring.

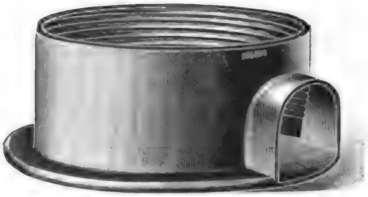


Fig. 6. Switch Base Box

Figs. 3 to 6. Showing various parts of Flush Switch Box.

the flush fittings are fixed in either ceiling or wall. This same principle of strong, air-tight construction is used also for wall

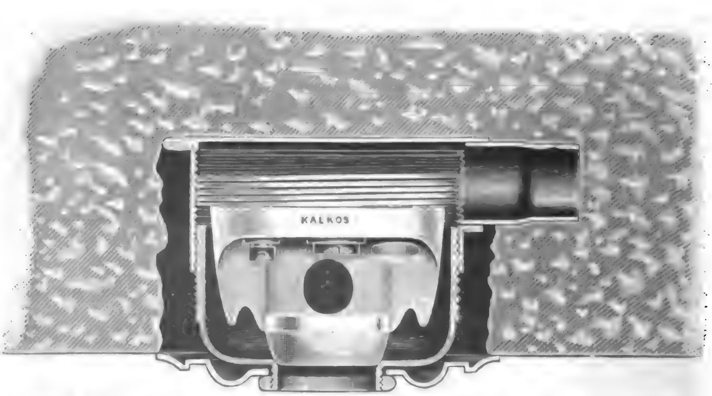


Fig. 7. Section showing Flush Ceiling Rose Box in Position. Complete with Ceiling Rose and Flush Plate.

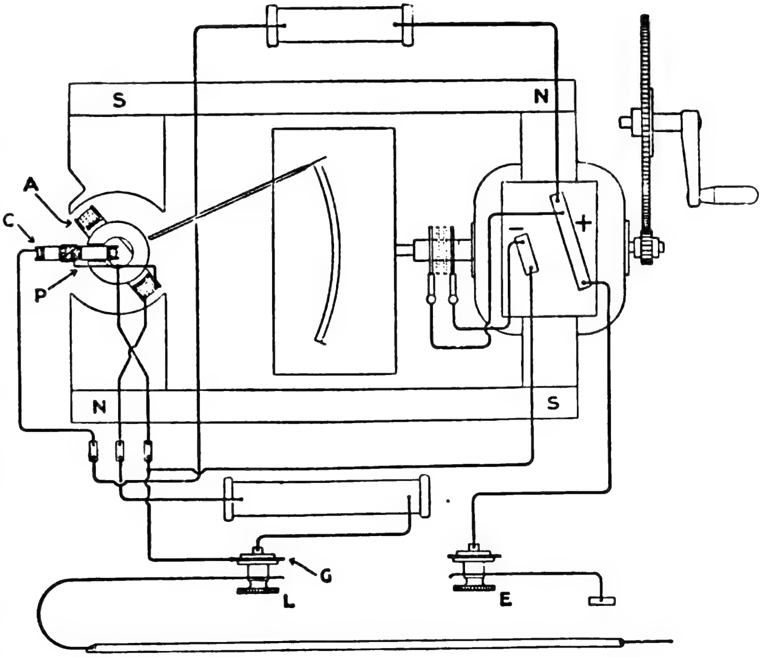
plugs, junction and inspection boxes, &c.

It may appear at first sight that this system is likely to be an expensive one, but in many cases it will be found to work out very cheaply. Firstly, it should be remembered that since the tubes are of brass all scraps and odd lengths are of good marketable value as scrap metal. More important than this, however, is the fact that it lends itself to the concentric system of wiring. The conduit system, being of brass with close-soldered joints, can be utilised as one conductor of the system. Thus on three-phase star systems the wiring for lights between any one phase and the earthed point of the system requires to have only one insulated conductor drawn into the conduit, the conduit forming the second earthed conductor. Not only is the cost of insulated wires thus reduced by half, but the size of duct is reduced since only one wire has to be drawn in. There is consequently a saving in the weight of conduits, saving in the work of cutting out for imbedding these conduits and increased speed of installation. The speed with which a soft brass tube of this size can be handled, bent, cut, and worked is self evident. Another point is that the conduit is practically everlasting. It is of course non-corrosive and there is no chance of rust furring the interior or destroying the neat external appearance. Taking into consideration the many advantages of this system it would seem that it is likely to come into very general use and will in all probability become standard for the highest grades of wiring work.

Meggers and Bridge-Meggers.

Evershed & Vignoles, Ltd.

THE modern form of the ohmmeter and magneto-testing set, used for years as a standard insulation-testing set, is the megger. In this the generator and the ohmmeter, of the moving-coil type, are assembled in one box, making a compact and readily portable instrument. In this, all connections are complete, the operator having simply to couple his test wires to the two terminals, turn the handle, and the scale reading is a true index of the actual resistance under test. There are two important features lately introduced into the megger design which further add to its convenience and accuracy. The pointer can be definitely adjusted to infinity with the instrument disconnected by turning the generator at full speed, and turning the knob of the index adjuster one way or the other until the index



A	=	Current Coil.	+ −	=	Generator Terminals.
P	=	Pressure Coil.	G	=	Guard Plate.
C	=	Compensating Coil	L, E	=	External (Line and Earth) Terminals.
N, S	=	Magnets.			

FIG. 1. DIAGRAM OF CONNECTIONS OF EVERSHED'S MEGGER.

(The dotted Commutator Rings are used in Constant-Pressure Meggers only.)

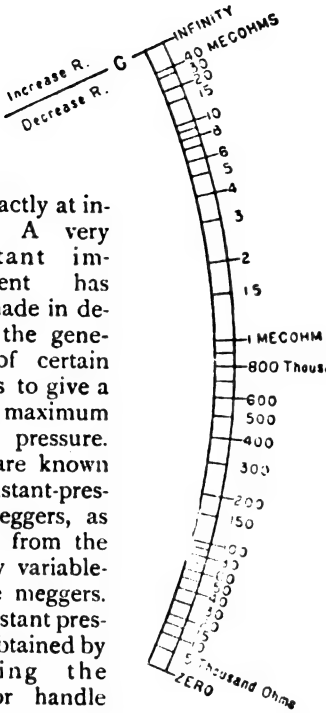


FIG. 2. SCALE OF EVERSHED'S BRIDGE-MEGGER (STOCK PATTERN).

rests exactly at infinity. A very important improvement has been made in designing the generators of certain meggers to give a definite maximum testing pressure. These are known as constant-pressure meggers, as distinct from the ordinary variable-pressure meggers. The constant pressure is obtained by arranging the generator handle to drive through a centrifugal friction clutch so that should the handle speed exceed a definite limit the clutch slips; by this means the generator speed is maintained constant within 0.02 per cent. The net result is that the generator becomes practically as good as a battery of cells for testing purposes, and it can be depended upon to give steady and accurate results of insulation tests in circuits having considerable capacity. For example, power cables with lead sheathing and telephone cables have usually sufficiently high electrical capacity to prevent any steady indication of the ohmmeter being obtained, owing to the surging currents passing into and out of the cable capacity with the rise and fall of the generator speed. The constant-pressure megger effectually prevents this; it maintains a constant testing pressure. This feature is one which led to its general adoption by the Admiralty; the lead-covered cables and wiring used throughout on shipboard have such high capacities that only a constant-pressure megger can be used for testing purposes.

FIG. 4. EVERSHED'S DIRECT-READING RESISTANCE BOX. PLAN VIEW.

The diagram Fig. 1 shows the complete internal connections of the megger, whilst Fig. 2 shows a typical scale. It will be seen that the latter, in addition to having the usual graduations of an ohmmeter scale, has a galvanometer zero mark G. As a matter of fact the scale illustrated is that of a bridge-megger.

The bridge-megger is in principle exactly as the megger just described, but has additional connections whereby it can either be used as a simple megger or combined with a special resistance box for use on ordinary bridge tests. In the latter case the ohmmeter serves as the generator.

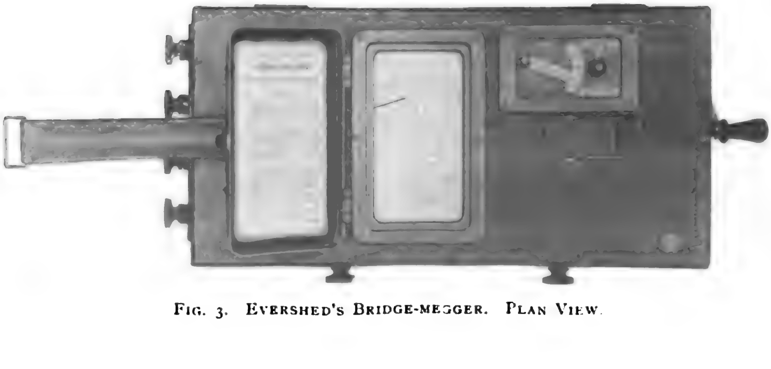


FIG. 3. EVERSHED'S BRIDGE-MEGGER. PLAN VIEW.

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FOR THE MACHINE ATTENDANT AND ELECTRICIAN.

Dynamo and Motor Attendants and their Machines. BY FRANK BROADBENT, M.I.E.E., &C. FIFTH EDITION. (LONDON: S. RENTELL & CO., LTD., 36, MAIDEN LANE, STRAND, W.C. PRICE 1s. 6d. NET.)

Conclusive proof as to the popularity of this book is the fact of this being its fifth edition; at the same time, we must hasten to say that it is quite up to date. The troubles of dynamos and motors, their detection and remedies, occupy a very considerable part, and it would seem that nothing has been omitted in this way. Great and little defects, whether caused by want of care, accident, or fair wear and tear, are systematically explained with a fullness and simplicity which must be to the understanding of any man, however unskilled, who has the charge of electrical plant.

The early part of the book describes the general principles of dynamo construction, and backs up a clearly written description with an excellent selection of drawings and diagrams. There are straightforward hints given as to the general care and maintenance of electric machines and their controlling apparatus and circuits. The keeping of generating plant records and the general systematising of the duties of electrician-in-charge or dynamo attendant are not overlooked. It is indeed astonishing that so much valuable information, forming a complete treatise of its subject, could have been compressed into a neat, cheap volume of handy size.

The book can be more than recommended for young engineers and those in charge of electric machines; it can be said to be indispensable to such, and no central station or private power installation should be without a copy.

Die Montage elektrischer Licht- und Kraftanlagen. VON H. POHL. (HANNOVER: MAX JÄNECKE. PREIS M. 2.40.)

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Prüfung elektrischer Maschinen und Transformatoren. VON FRIEDRICH WEICKERT. (HANNOVER: MAX JÄNECKE. PREIS M. 1.80.)

A work intended to serve as a handbook for electrical engineers in testing electrical machinery.

The first portion describes the different types of instruments used; the second deals with the various methods of testing in vogue, whilst the remainder of the book is devoted to the testing of: Direct-current machines; accumulators; alternating-current generators; synchronous motors; single, double and three-phase motors and transformers. Much useful information and data are given.

Die Krankheiten elektrischer Maschinen. VON ERNST SCHULZ. (HANNOVER: MAX JÄNECKE. PREIS M. 1.40.)

A useful book for those in charge of lighting or power plants. The contents deal with the disturbances in electrical systems and faults in electrical machinery, their symptoms and remedies. The subjects are arranged with headings in heavy type, and any desired subdivision may be readily referred to.

Amongst others, the chief subjects dealt with include direct-current machines and single- and poly-phase generators, induction motors, and transformers.

How to Use Water Power. BY HERBERT CHATLEY, B.SC. ENGINEERING., MEMBER SOC. ARTS. (MANCHESTER: THE TECHNICAL PUBLISHING CO., LTD., 287, DEANSGATE. PRICE 2s. 6d. NET.)

This is a small book which is very suitable for the general engineer or student who requires to have a knowledge of the fundamental principles of hydraulic machinery and some information of the design of the commonest applications of water power. The title of the book is somewhat misleading. As a rule one associates the use of water power with the actual generating of electrical units or brake horse power from an available natural waterfall or stream. The book under notice certainly touches upon that phase, but it deals more generally with hydraulic engineering as applied for instance to the heavier type of machine tools and for portable heavy power or lift services. The book can be recommended as being a concisely written elementary treatise on hydraulics. It gives much numerical data as to design and performance and contains a series of useful illustrations.

FOR THE PROSPECTIVE ENGINEER.

Life as an Engineer. BY J. W. C. HALDANE, M.I.MECH.E. (LONDON: E. & F. N. SPON, LTD., 57, HAYMARKET. PRICE 5s. NET.)

This is a handsome little volume which will be appreciated by the engineer in his leisure moments. It is a personal narrative written throughout in an entertaining manner; indeed it is to some extent an autobiography dealing with the work done and impressions received by the author during a long connection with a wide variety of engineering schemes and spheres of labour. It is consequently a book to appeal to the prospective engineer, and will be read with avidity by the aspiring youth; it will be to that youth's advantage moreover, for running through the book is a happy vein of encouragement and advice. There are not many books of this class, and Mr. Haldane's work should certainly be known very generally as a book well worth reading by anyone nterested as an engineer, or as in the position of one who has the guardianship of those desiring to enter the engineering profession.

Guide to the Engineering Profession. BY W. GALLOWAY DUNCAN. (DUNDEE: JAMES P. MATHEW & CO., 17, COWGATE. PRICE 3s. NET.)

How very often the engineer is appealed to by parents or aspiring youths for directions as to the way to become an engineer. To all such enquirers the little volume under notice will be of service. It is indeed an interesting "Guide," dealing separately and thoroughly with each of the distinct branches of engineering. In turn chapters are devoted to civil engineering, mechanical engineering, electrical engineering, and to mining engineering. In each case the range of work entering into the profession, the steps which are desirable or necessary for full qualification and details of the training to be taken up, are set forth in a concise and easily read form. Other chapters are given to the science of the engineering workshop, reports of technical societies on the training of engineers, particulars of the engineering courses at the technical institutes of Manchester, Glasgow, and Dundee, conditions of pupilage and apprenticeship at Messrs. Yarrow's works, and so on.

The book has a series of well-selected illustrations; its great feature however is the happy way in which sterling advice and encouragement are tendered to the beginner. It is more than a guide to the engineering profession; it is a little collection of good maxims which every student should read carefully, remember, and work by. In effect this is a unique volume, which will be found of great service by old and young alike.

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Containing about 300 pages of letterpress and numerous insets of office forms and record sheets, this little book is a remarkably cheap production. Every phase of office routine and the commercial and financial sides of business are set out in detail. It is not a compilation of chapters illustrating merely the exceptional merits of such-and-such a line of card-indexes or filing materials and method. There does not seem to have been any feature of office management neglected. Starting with the control and qualification of members of the staff, such subjects as correspondence, contracts, tenders, packing, transport, advertising, accounts, finance, law, insurance, &c., are all entered into, and so well as to make the work an unfailing handbook for reference purposes.

New Catalogues.

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Frequency Meters, &c.—THE UNION ELECTRIC COMPANY, LTD., London, S.E.—This list gives description and prices of a line of alternating-current instruments designed to the Hartmann-Kempf patents. The instruments include frequency meters in various forms, as synchronisers, switchboard types, portables, desk types, alarm meters, &c. All connected with alternating-current power work or interested in the study of alternating current should apply for a copy of this list.

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Cooling Towers.—RICHARDSONS, WESTGARTH & CO., LTD., Middlesbrough. An illustrated folder giving brief particulars of the convex splash bar cooling towers made by this firm. This system has many points to recommend it and power station engineers should be acquainted with its details.

Flame Arc Lamps.—THE BRITISH THOMSON-HOUSTON COMPANY, LTD., Rugby. Pamphlet No. 205 gives description of a special line of flame arc lamps and parts. The B.T.H. Co. have also recently issued price-list No. 123, dealing in a similar manner with twin-carbon arc lamps of dust-proof type, and pamplet No. 206, which is devoted to description and illustrations of motor-control panels, including enclosed-type starters, switches and fuses.

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Alternating Currents.—An analytical and graphical treatise for students and engineers. By FREDERICK BEDELL, Ph.D., and ALBERT CUSHING CREHORE, Ph.D. Fourth edition, with 110 illustrations, 325 pages, 8vo, cloth. (New York, 1904.) 10/6 net.

Practical Electric Railway Handbook.—By ALBERT B. HERRICK, Consulting Electric Railway Engineer. Second edition, revised and corrected, with 329 illustrations, 460 pages, 12mo, leather. (New York, 1906.) 12/6 net.

Electrical Practice in Collieries.—By D. BURNS, M.E., M.Inst.M.E., Certificated Colliery Manager, and Lecturer on Mining and Geology to the Glasgow and West of Scotland Technical College. A clear and concise introduction to electrical practice in collieries. Contents: Units of Measurement, Conductors, &c.—The Theory of the Dynamo—The Dynamo, details of Construction and Working — Motors — Lighting Installations in Collieries—Pumping by Electricity—Electrical Haulage—Coal Cutting—Miscellaneous Applications of Electricity in Mines—Coal Mines Regulation Act (Electricity)—Index. Second edition. In crown 8vo. Handsome cloth. With 30 new illustrations. 7/6 net.

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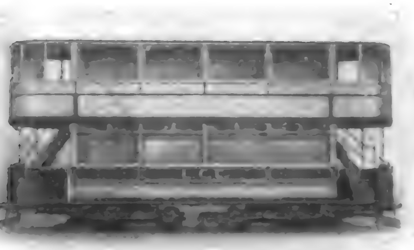

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For LITERARY CONTENTS of this Number see page 6.

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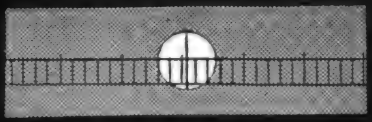

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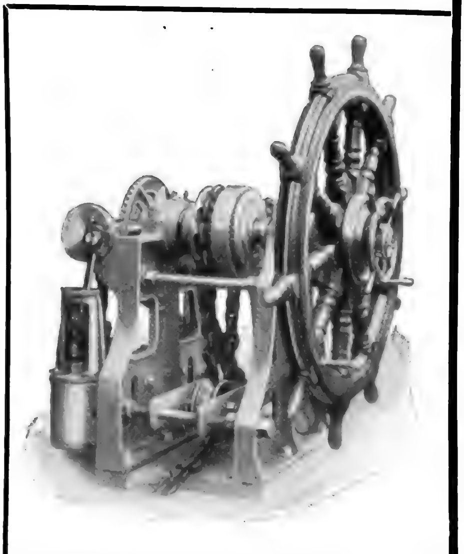

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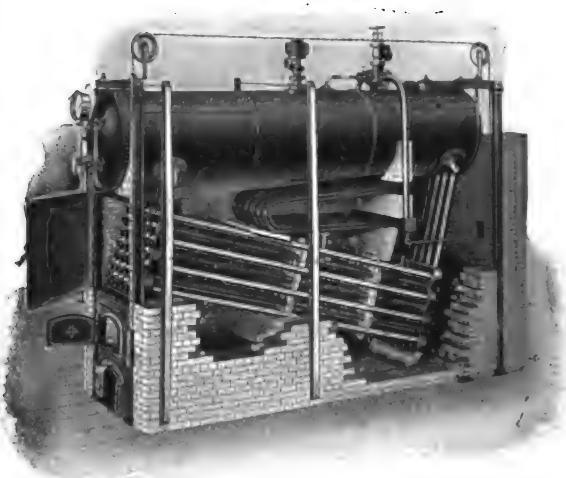

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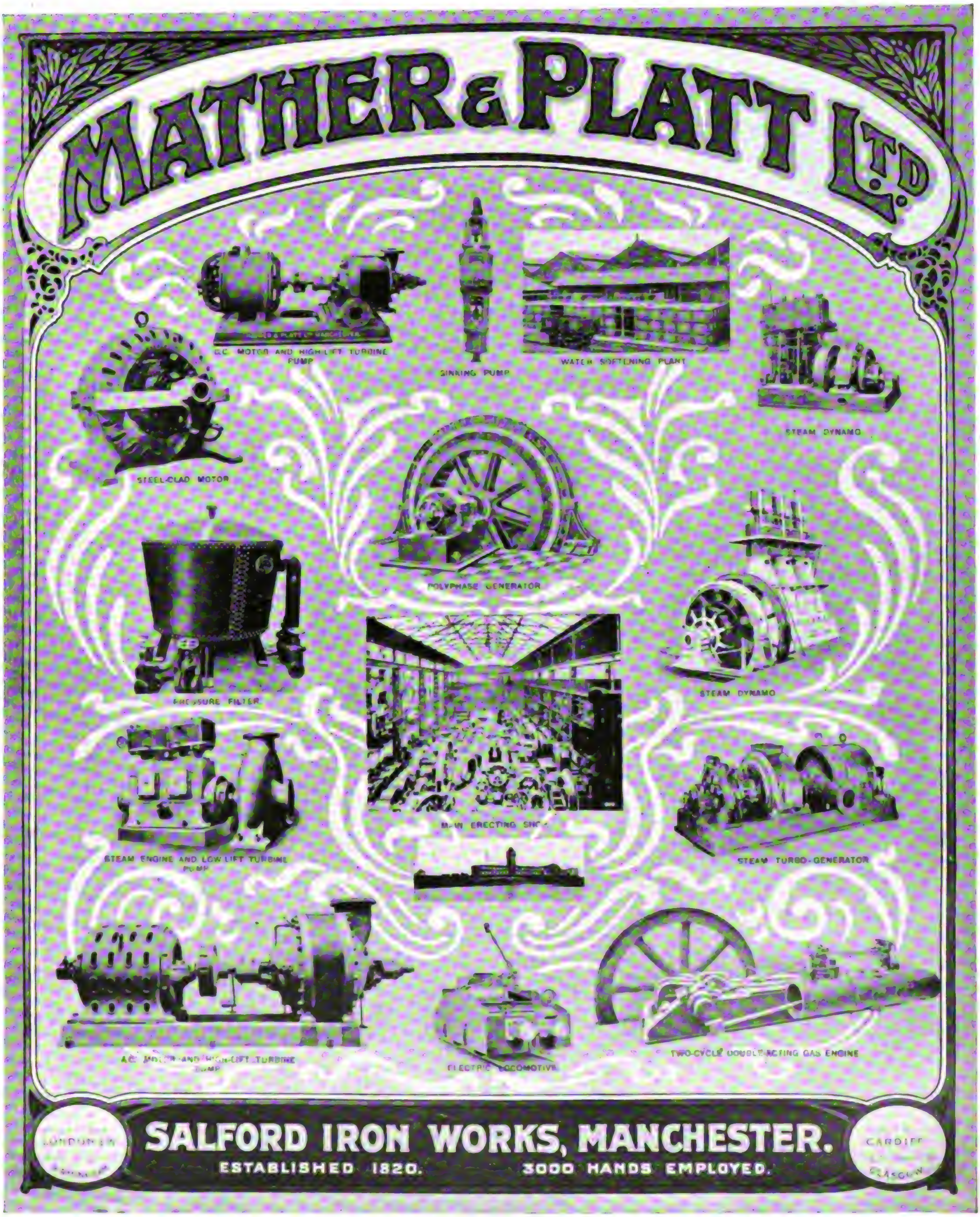
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(47th Issue.)

The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. VIII. No. 5. LONDON. NOVEMBER 30th, 1907.

The World's Electric Progress.

Domestic Electric Heating.

THE use of electricity for domestic heating and cooking purposes is certainly advancing in favour, although it cannot be said that progress in this direction is a matter of leaps and bounds. The actual cost of current per pound of potatoes or pint of water boiled is still fairly high as compared with the corresponding figures of the gas stove. But there are many processes and labours of everyday usage and custom which are regularly effected in a manner or on a scale obviously not the cheapest so far as cash expense is concerned. The elements of convenience and comfort are all-powerful in the generalities of life, the which can be summed in the one word "domesticity." It is, after all, the cook who will decide between the merits of electricity and gas as for cooking; and there is an ever-increasing voice from this quarter in favour of the former. It may be taken for granted that where residential electric lighting is encouraged and particularly sought after, a good proportion of electric heating and cooking service will result as a natural consequence.

In those cases where electric cooking appliances have been adopted and where the charge for current has exceeded anticipations, it will be found often that a little care in the kitchen system and a more frequent use of the electric switch will make a wonderful difference at the quarter's end. This same trouble was, and is still, very common with electric lighting; the householder, accustomed to gas or oil, forgets, or does not realize how important it is to switch off the light whenever it is not in actual use. Even should he be passing in and out of a room at intervals of only a few minutes, it pays to touch the switch at each entrance or leaving. The rule of switching on and off just when the supply is needed or finished with is one which should be observed in every household as it is in every power-house or works employing motors. It is merely that one has to acquire the habit, and certain economy is the result.

On page 307 of this number a table of costs of cooking by electricity as compared with other methods is given. The figures, which do not stand in favour of electricity, have reference to actual quantities of the respective fuels or current used: the advantages of electricity are dealt with concisely and forcibly in another part of the article. The writer gives the results of actual practical experience, and the total outcome is distinctly in favour of the newest heating agent.

The popularising of electric cooking and heating methods in this country rests with the central-station man; it is for him to advance the new method and advise the likely user at every opportunity, and despite the general opinion which prevails as to electricity being dearer than gas for cooking purposes, he can to-day be more than ever certain that those who do essay a trial will not be disappointed with the nett result. Experience proves that although the electric bill may be somewhat higher than the old gas bill, there are many other advantages and economies gained which far more than offset the difference.

Another article in our Lighting and Heating Section this month is also devoted to electric heating, although possibly the system described is so extensive as to hardly warrant the use of the adjective domestic. The laundry and general hot-water service of a Vanderbilt residence entails naturally an exceptional outfit: that is not remarkable where an American millionaire is concerned. The importance of this particular equipment is the fact that it is a great electric heating plant of commercial value. It was found that for the water-heating system the current used was, during eleven months continuous service, actually 12 per cent. less than had been estimated in working out the preliminary figures of the system. The nett result has been a saving by the electric system over the original coal-fed boiler arrangement. The energy consumed per month amounts to an average of 19,000kw.-hours, the cost of which is about £33; the old plant costing about £35 per month for fuel and labour.

The equipment of the laundry and drying room was made entirely dependent upon electric power and heat; details of the work done are given in the article under notice. It is particularly noticeable that no special efforts were made to ensure a fine degree of efficiency in the several processes, the main objects being to ensure simplicity and quietness during erection and operation; yet the result has been the saving of £105 per annum over the old system.

Essays for Engineers. Not the least valuable feature of American method in technical education is the custom which brings forward representative leaders of industries and professions to deliver to students addresses which are based upon the personality and characteristics of men. The subject is the widest of any and yet it has proved the most elusive so far as the maker of books is concerned. Whilst it is one which does not lend itself to the usual text-book treatment, with its elementary stages, advanced courses, chapter and volume and definite subdivision, it is undoubtedly the subject which above all is suited for oration. The observant man has always in this a theme around which he can weave a discourse at once convincing, interesting and valuable, and moreover one which will be understood and appreciated by every hearer. To speak in public of one's fellow men is to at once seize the audience; to show an insight into the motives and inner sides of man's character and to deduce therefrom principles which shall be for the guidance of everyone to a general betterment, is to keep the audience and satisfy it.

There can be no denying the fact that student engineers in this country would welcome such an address as that delivered at an American technical college and of which some extracts are given in our Students' Section this month. We have from time to time, and frequently for a year past, reprinted selections from several addresses of similar character all hailing from the other side, and it is this fact of common source which emphasizes the need of a similar custom in this country. As to the real good which is served by these addresses of the wise and successful there can be no two opinions. Perhaps our colleges and those scientific and technical institutions which have as a main object the assistance of engineering students

and apprentices will make a special feature of encouraging and promoting this class of "technical paper." They certainly should do so, for its popularity is assured, and the benefit which would accrue to the industry in general is self-evident.

High-tension Transmission without Switchgear.

A BOLD suggestion is brought forward by Mr. R. Coryton Roberts in a recent number of *Electrical Engineering*; he proposes that the parallel running of alternators be abandoned as an old-fashioned principle. It would seem that this revolutionary idea has its origin in a feeling that the present-day large-sized power plants and extra high-tension transmissions are developing to such an extent that we can no longer control them with safety and certainty; that we have reached our limit in switchgear design, and that all our present-day efforts to adapt the said switchgear merely results in added complication and risk of breakdown.

It would at all events seem that there is some good cause for bringing the matter forward, and indeed practice has already seen some steps taken in the direction of simplifying high-tension a.c. systems in this manner. The use of the larger-sized a.c. motors fed direct with high-tension currents is not uncommon nowadays, and moreover it is particularly used in connection with mining installations where the roughest operating conditions prevail. To quote the most recent example, there is the high-power pumping installation of the Lindal Moor Mines, fully described in our last number. It should be further noted that in this particular mining plant no controlling or starting apparatus is placed alongside the motors or even at the pit; but that the motors are started and stopped by switchgear located at the power generating station, and that by way of overhead-transmission lines and long shaft cables, the power passes direct into the motor windings without the intervention of any switch-gear beyond the power house. It is not a much greater development to so arrange a power system that the h.t. switch-gear shall be abolished from the central station, and located at the motor, or sub-station, ends of the transmission.

In the words of the author who writes in our contemporary, "Switchgear is inseparable from the system of parallel operation, but there is no reason why this system should be slavishly adhered to if advantage can be gained by departing from it."

Stating generally that the article refers more particularly to a.c.-d.c. systems with underground transmissions, it is pointed out that the abolition of parallel running would practically mean that the d.c. substation generator and the central station engine would form a generating unit. This arrangement would naturally interfere to some extent with the flexibility of an installation, and would also affect the question as to the best size of generating unit to be used. The author's consideration of the merits of his proposition includes the following main points:

The difficulties of charging up feeders and switching on large h.t. motors might be entirely eliminated. By running up the engine, with a low excitation on the alternator, the unloaded motor at the substation could be simultaneously brought up to speed, and the effects of any resonance of harmonics kept within bounds until the full, and therefore safe, periodicity was reached, and normal conditions realised. With an efficient telephone system, this is quite possible and has been done.

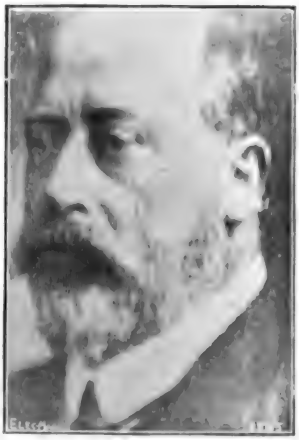
No synchronising would be needed, and even if synchronous motors were tried for the sake of a high power factor, a predetermined adjustment of the field rheostats at the generating station and at the substation should cover all requirements. The d.c. generators could be put on load practically as soon as the complete unit reached full speed, a saving of time of no mean importance under emergency conditions.

Automatic protective devices could be reduced to the simplest form, if not entirely avoided. A reverse cut-out on the d.c. generator would give protection in case of power pumping back from the d.c. busbars and the arrangement of the h.t. system ought to permit of an alternator with a high reactance being used, thus making the h.t. side to a large extent self-protective from power pumped into

a fault from the engine end, at any rate for a sufficient time to permit the engine to be shut down by hand. An automatic signal could be operated by a simple overload device, and this might, if desired, be extended into a fairly reliable automatic steam cut-off.

On the score of safety and economy of space, the absence of switchgear could not but prove a step in the right direction. Series transformers bolted up between the terminals of the machines and the cable boxes would provide low-tension current for the operating and testing instruments, and for the automatic signal. Voltmeters could probably be dispensed with, and the exciter ammeters and speed indicators used as indirect means of checking the voltage conditions well enough for all working purposes.

The chief advantage of all would, perhaps, lie in the enhanced reliability of supply ensuing from a complete isolation of each unit of h.t. transmission. It is a deplorable fact that, in spite of all the ingenuity which has been expended on protective apparatus—spark-gaps and automatics of various designs, both simple and weird—a really bad short circuit on any one of several h.t. cables running in parallel will, in all probability, start a disturbance which may travel back to produce a secondary failure miles away, and possibly entail a complete shut-down.



Telegraphing Photographs. By the courtesy of the *Daily Mirror* we are enabled to reproduce the accompanying photograph of H.M. King Edward, which is of interest as being taken from the first negative to be transmitted electrically to this country from abroad. The photograph was forwarded by telegraph and cable from the office of *L'Illustration* in Paris to the office of the *Daily Mirror* in London on the 8th inst. The system used is that developed by Professor Korn, of which we give some general particulars in the Telegraphy Section of this number.

But already there is threatened a Franco-German tussle in this the newest electrical development. From the description which we also give in this number of M. Belin's system of telegraphing photographs, it will be seen that Prof. Korn of Munich and M. Belin of Nancy are likely to be engaged in keen competition. The rival methods resemble each other only so far as the fine subdivision of the copy and its reproduction step by step is concerned. In the Korn system this subdivision is very apparent in the result, the transmission being practically a succession of many distinct impulses. We have not seen a picture as made by the Belin receiver, but it would appear that the effect in this case would be more nearly an exact and soft reproduction of the original. In the former system the distinctive physical property of selenium is utilized, in the latter the mechanical perfection of the oscillograph is the key to the invention. There is therefore all the difference in the world between the rival systems, and we can look forward to seeing remarkable developments in the near future.

There can be no doubt as to the commercial value of this the latest development of applied electricity. One has but to consider the ever-increasing popularity of the illustrated newspaper, of the living-picture exhibitions of current events, and, indeed, of the present demand for illustrations and pictures of all classes of news, to realise that the perfection of picture telegraphy means the birth of a new industry. Apart from the value of the process to popular journalism and the general interest of the public, there are many other uses which will suggest themselves to readers. Descriptions of places, sites, events, and personalities are very frequently required quickly and accurately for other purposes than to gratify public curiosity.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Variable-speed Motors for Heavy Work.

Now that the advantages of variable-speed motors for driving heavy machinery and tools are being more and more widely recognised, the following notes as to the performance of some powerful continuous - current motors with wide range of speed cannot fail to be of considerable interest to electric power users. The particulars given are of motors built by Messrs. Siemens Brothers Dynamo Works Ltd., who make a speciality of such work, and who have achieved notable success in this direction.

Before referring to the working results of typical examples of these heavy power variable-speed motors it should be mentioned that the methods employed by this firm for obtaining sparkless commutation and stability at all loads are as follows :—

All machines of the variable-speed type are fitted with commutation poles and the distortion of the fields is reduced by providing a long air gap. Compound winding is used in those cases in which the range of speed required exceeds about 3 : 1, and other special arrangements are adapted in very large machines for a wide range of speed or high voltages. These expedients for obtaining sparkless commutation are materially assisted

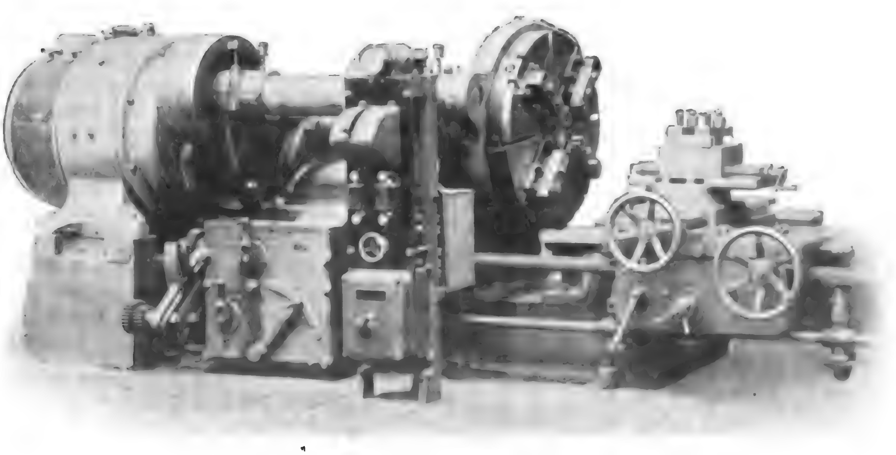


Fig. 1. General View of Variable-speed Motor Driving Lathe.

by the large commutators with many segments with which all motors are fitted.

The illustrations show a type 15FC. motor driving a high-speed lathe with 18in. centre and all gear head The drive is by means of toothed gearing, the pinion on the motor shaft being of raw hide. The face plate can be run at two speeds for each motor speed by means of change gears which reduce the motor speed to one twenty-fourth and one ninetieth respectively.

It will be noticed that the motor is fixed on an extension of the lathe bed, and is readily accessible for inspection, oiling, and so on. The motor speed can be regulated from 400r.p.m. to 1400r.p.m. by a rheostat having twenty-six steps, so that the face plate may be run at fifty-two different speeds ranging from 4.5r.p.m. to 58r.p.m The motor is fed with current at 500 volts, and develops from 28b.h.p. to 35b.h.p.

The following table gives the cutting speeds and the maximum and minimum diameters of work at the extreme ranges of the motor speed.

	Motor speed revs. per min.	Speed of face plate, revs. per min.	Diameter of work, inches.	Cutting speed, feet per min.
Max.	1440	58	2	31
	1440	58	5	76
Min.	410	4.5	26½	31
	410	11	26½	76

The lathe is in operation at Messrs. Siemens' Stafford Works, and the tables A and B on the following page contain the results of some interesting cutting tests which were carried out at the beginning of this year.

A 200h.p. motor for 230 volts and 200r.p.m. to 450r.p.m. was supplied in October, 1906, to the order of Messrs. John Brown & Co., Ltd. The machine is shunt wound and fitted with commutation poles. In a six hours' run its rise in temperature did not exceed 50deg. F. in the armature and 30deg. F. at the commutator and the field coils. The machine runs absolutely sparklessly throughout the whole range of speed, not only at normal load but also on overloads up to 50 per cent. Since the first machine began running, a second motor has been supplied to the firm.

Interesting on account of its very wide range of speed is a 5h.p. motor which was supplied to Messrs. J. Buckton & Co. for Woolwich Arsenal, the speed varying from 170r.p.m. to 1020r.p.m. The supply voltage is 500 and the machine is fitted with commutation poles. The machine is perfectly stable at all speeds and at all loads up to

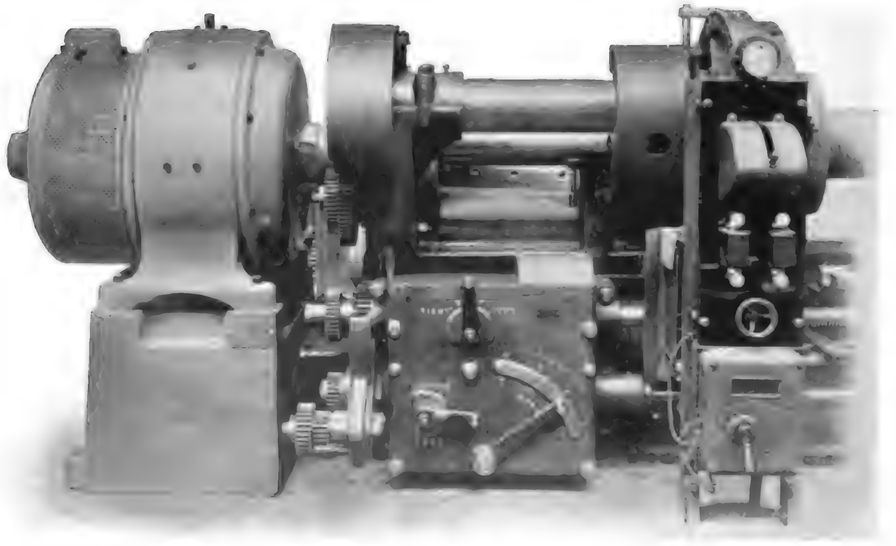


FIG. 2. NEARER VIEW OF LATHE, MOTOR, AND SWITCH-GEAR.

TABLE A.

MILD STEEL.

Motor speed, r.p.m.	Face plate speed, r.p.m.	Cut, inch.	Feed per rev., inch.	Amps. Lathe running idle. Single gear.	Amps. on cut.	Cutting speed, feet per min.	Time of run, minutes.
700	29	$\frac{1}{2}$	$\frac{1}{12}$	10	25	53.6	1
600	26	$\frac{17}{32}$	$\frac{1}{15}$	10	20-30	48.5	5
700	29	$\frac{11}{16}$	$\frac{1}{12}$	10	30-40	56	6
720	30	$\frac{1}{2}$	$\frac{1}{8}$	10	63	56	1
720	30	$\frac{1}{2}$	$\frac{1}{8}$	10	60	56	1
820	33	$\frac{1}{2}$	$\frac{1}{12}$	10	35	61	4
850	35	$\frac{1}{2}$	$\frac{1}{8}$	10	60	64	2
850	35	$\frac{1}{2}$	$\frac{1}{8}$	10	60-80	67	$1\frac{1}{8}$
1005	39	$\frac{1}{2}$	$\frac{1}{8}$	10	65	62	1
930	39	$\frac{1}{2}$	$\frac{1}{8}$	10	63	62	1
950	39	$\frac{1}{2}$	$\frac{1}{8}$	10	65	64	1
1320	54	$\frac{1}{2}$	$\frac{1}{8}$	10	60	75	3

TABLE B.

CAST IRON.

Motor speed, r.p.m.	Face plate speed, r.p.m.	Cut, inch.	Feed per rev., inch.	Amps. Lathe running idle. Double gear.	Amps. on cut.	Cutting speed, feet per min.	Time of run, minutes.
1100	12	$\frac{1}{4}$	$\frac{1}{18}$	9	12	31.5	1
1300	15	$\frac{3}{8}$	$\frac{1}{12}$	10	15	39.2	1
1300	15	$\frac{1}{2}$	$\frac{1}{12}$	12	15	42	1
1420	16	$\frac{1}{2}$	$\frac{1}{12}$	12	17	52.5	1
1800	20	1	$\frac{1}{24}$	12	19	52.5	1
1800	20	1	$\frac{1}{16}$	12	20	Tool smashed.	
1800	20	1	$\frac{1}{24}$	12	20	Tool smashed.	
1800	20	1	$\frac{1}{12}$	12	20	Tool smashed.	
1600	18	$\frac{3}{8}$	$\frac{3}{16}$	12	20	47	1
1600	18	$\frac{1}{2}$	$\frac{3}{16}$	12	21	47	1
1400	16	1	$\frac{1}{24}$	12	18-21	42	3
1420-50	16	1	$\frac{1}{14}$	12	20-22	42	10
410	18	$1\frac{3}{32}$	$\frac{1}{12}$	10 Single Gear.	22	38	6

100 per cent. overload. The machine is designed with a very long air gap and large commutator. As the machine is to run in both directions the brushes are fixed in the neutral position. On test the commutation was perfect over the whole range of loads and speeds. After a six hours' run the following temperature rises were observed: armature core, 27deg. C.; commutator, 20deg. C.; shunt coils, 35deg. C.; commutation coils, 20deg. C.

A 100h.p. 500-volt motor, with range from 100r.p.m. to 600r.p.m., has since been built for the same firm.

The Electric Drive in Cement Works.

ELECTRIC motors are now very frequently adopted for the driving of the various machines used in cement manufacture. In this class of work there is particular merit in the elimination of belting and countershafts, for the reason that the sharp gritty dust renders the maintenance of such a very expensive item.

Whilst direct-current motors are in considerable use for this service, it may be taken as the better practice to put down polyphase motors, and in most recent installations this has been done. The simplicity of the squirrel-cage rotor of the induction motor naturally makes for reliable operation in the dust-laden atmosphere of cement mills. It has become quite a standard practice in America to fit modern cement mills throughout with polyphase driving plant.

In these mills the motors are used for operating rock crushers, ball mills, tube mills, rotary kilns, hoists, conveyors, pumps, &c.; in fact for all the machines required in a modern cement plant. In most instances the motors are run at or near full load continuously, and the service as a whole is especially severe. In nearly all cases the motors used are of the squirrel-cage type, with short-circuited secondary—a type that necessarily operates at constant speed. For variable-speed work the induction motors are provided with a wound rotor connected through collector rings and brushes to an external resistance. However, even slip-rings and brushes are undesirable features when exposed to cement dust; slip-ring motors are installed occasionally for operating rotary kilns, where a variation in speed is sometimes desirable, and also for electric hoists; but for practically all other classes of work constant-speed squirrel-cage motors are used.

Probably the most severe service is that demanded of motors for running ball and tube mills. These mills are used for grinding the raw material before calcining, and also the clinker from the rotary kilns. A recent article in the *Western Electrician* gives some figures of the motor powers desirable for this class of service. For driving the ordinary sized ball mill a 50h.p. motor is required, while for a 5ft. by 22ft.

tube mill a 75h.p. motor is usually installed; a 5½ft. by 22ft. tube mill requires about 95h.p., and a 6ft. by 22ft., 115h.p.; the 5ft. by 22ft. mill is the size generally used.

Ball and tube mills, especially the latter, are difficult to start. The material clings to the sides of the mill, particularly in the tube mill, where pebbles are used to effect the grinding, and at starting the whole mass has to be swung up until the first half-revolution has been made. This demands heavy starting torque, usually amounting to 1½ to 2 times full-load torque. It is desirable, therefore, to use for these mills a motor having starting torque higher than for ordinary service. Motors for this service must be of liberal size to give the requisite starting torque, and they must also operate continuously at full load in a dusty atmosphere without undue rise in temperature. It must be remembered that in cement mills the fine dust gets into the ventilating passages in the motor, and they may in time become clogged up, thus materially increasing the temperature rise.

The starting apparatus used must also be of liberal design in order to carry heavy starting currents. Sometimes the mills are started by throwing the current off and on, giving them two or three swings until they finally turn over. This is especially hard on the stator, and should not be necessary if the motor has ample starting torque. All starters have oil-immersed switches for changing the connections from "starting" to "running," and transformers are provided so that a reduced voltage can be applied to the motor at starting, thus reducing the current taken from the line.

On 60 cycles, 50h.p. motors running at approximately 850r.p.m. full load have been used for ball mills, but a slower speed motor is more desirable, and 670r.p.m. machines are now recommended. On 25 cycles, four-pole motors running at approximately 700r.p.m. full load are used.

For 5ft. by 22ft. tube mills a 75h.p. motor running at 670 full load on 60 cycles is suitable, while on 25 cycles speeds of 700r.p.m. or 470r.p.m. are available, the latter being preferred. Motors are belted direct to the main driving shaft on the mill, from which the latter is driven through spur gearings.

Although there are instances where 2200-volt motors have been used, the lower voltages are preferable on account of the greater security of the insulation on the motors and greater safety in working around them.

As regards mechanical features, it is important that the motor-bearing sleeves be arranged so that they can readily be removed and relined. All bearings are made as dust-proof as possible by means of felt dust guards, and journals are of liberal dimensions.

Cost of Electricity from Small Gas Producer Plants.

An enquiry to the Canadian Electrical Association elicited the following data as to the cost of energy from a 100h.p. gas producer plant. Anthracite coal with a calorific value of 12,000b.t.u. was assumed, costing $5 (21s.) per ton in pea size. The producer efficiency was 78 per cent. The first cost of a 100h.p. suction gas producer, engine and compressed-air starter, together with erection and foundations, was taken at $7000 (£1458). The attendance is small if the plant is properly equipped, an allowance of four hours per day being ample.

The plant consumes 1lb. of coal per h.p.-hour, or 1000lb. per 10 hours, and the stand-by losses of the other 14 hours will will not amount to more than 30lb.; hence the fuel was taken at 1030lb.

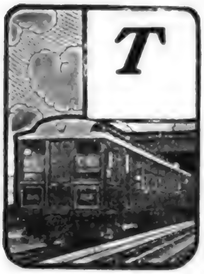
OPERATING COST.

Engineering at 25 cents per hour, 300 days (4 hours each)	$300.00	(£62)
Coal at $5.00 per ton, 154.5 tons	773.00	(£161)
Oil and waste	230.00	(£48)
Interest on investment at 8 per cent. ..	560.00	(£117)
Depreciation at 8 per cent.	560.00	(£117)
Insurance, repairs, taxes	250.00	(£52)
Total	$2,673.00	(£557)
Per h.p.-year	$26.73	(£5.57)
Load factor, 100 per cent.		

To this must be added the cost of water used to cool the engine and that used in the scrubber, 4.5 gals. per h.p.-hour; the water used in cooling the cylinder can be used over again if cooling tanks are employed; the allowance for the scrubber and vaporizer is 3 gals. It is inadvisable to use again the water that has passed through the scrubber and been purified, because if there is a large percentage of sulphur in the coal, the sulphurous acid generated in the producer acts on the wrought iron of the scrubber. Repairs to the producer consist of removing the firebrick lining, once a year as a minimum, and sometimes once in three years. The coke in the scrubber requires removal about twice a year.

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

Single-phase Equipment of an American Railway.



THE first American steam railway to substitute single-phase motors for steam locomotives in the propulsion of its trains was the Erie, on its Rochester Division. The section of road equipped is thirty-four miles long; it is entirely single-track, with sidings at stations, averaging three to four miles apart. The grades are light, and the curvature for the most part quite easy, the line being relatively quite straight.

The electric service is devoted solely to passenger traffic, which is of the local inter-urban type. There are in use six motor-cars, each of which is equipped with four conductively-compensated series-connected single-phase motors of Westinghouse manufacture. These motors are operated with 25-cycle current taken from auto-transformers which receive their supply at 11,000 volts from an overhead catenary trolley wire. The motors are provided with compensating field coils for neutralising the armature reactance, and thereby improving the power-factor, and they are equipped with "preventive resistance leads" between the commutator segments and the armature winding to minimize sparking at the brushes. The auto-transformer on each car is rated at 200kw., and is of the oil-insulated self-cooling type. It has three high-potential and eight low-potential taps, the e.m.f.'s of the latter varying from 300 volts to 110 volts.

All the switches connected with the trolley mechanism, the auto-transformer and the motors are operated by compressed air, the valves for which are controlled electro-magnetically. The car equipment, therefore, includes three distinct electrical circuits: the high-potential 11,000-volt trolley circuit; the low-potential motor circuit, the e.m.f. of which does not exceed 300 volts; and the control circuit, the e.m.f. of which is 15 volts.

The high-tension wiring of the car consists mainly of varnished cambric cable, drawn through loricated iron conduit. A small amount of high-grade rubber cable is used, but it is thoroughly protected with varnished cambric tape wherever there is danger of a brush discharge to ground breaking down the insulation. The high-potential circuit passes from the pantograph trolley through the line switch to the 11,000-volt tap on the auto-transformer. The trolley mechanism is operated by a pair of springs, and by an air cylinder. The trolley is raised and held against the wire by means of springs, and it is lowered by the application of air pressure to pistons working in cylinders that form part of its base. When down it is automatically locked, and the latch of this lock can be withdrawn only by applying air pressure to another small piston, which then unlocks the pantograph, allowing the springs to raise it. The trolley mechanism is so connected with the control circuit through the line relay that any interruption in the supply of high-tension current immediately causes the trolley to be lowered by applying the air to the main cylinder in the trolley base.

The line switch is equivalent to a main high-tension circuit-breaker. It is opened

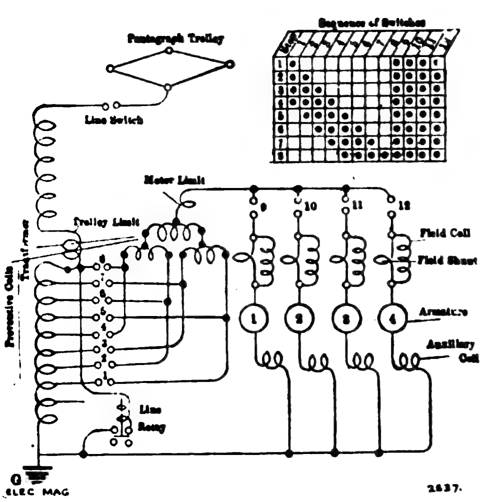


Fig. 1. Diagram of Controller Connections.

and closed by air pressure, admitted by electrically operated valves. In case the supply of air is exhausted, as when the car has stood for some time unused, the line switch must first be held in mechanically by means of a handle provided for the purpose until the air pump, which can then be placed in operation, has compressed air to a pressure of about 50lb. per square inch, which is sufficient to actuate the control system. For the purpose of raising the trolley when there is no air pressure, there is provided a small motor-car tyre pump placed underneath one of the car seats, which is connected by a three-way cock into the trolley air-piping system, and enables the air-operated trolley latch to be withdrawn and power obtained that will start the air-compressor and set going the motor generator set, which is used for charging the storage battery and supplying energy to the control circuit.

In the main low-potential circuit are the switch-group, the reverser, and the "preventive coils." All the switches of the group are provided with interlocks, which automatically govern the connections in such a way that each switch of the group acts only when the current in the motors has decreased to a predetermined value, thus making the acceleration automatic. The "preventive coils" are small auxiliary auto-transformers used in connection with the main transformer in order to prevent the short-circuiting of the intervening turns when the motor connections are changed from one tap to another on the main auto-transformer.

The control circuit includes a master controller in each vestibule, the train line wires and their connections to the valve magnets and interlocks, a storage battery supplying energy for these wires, and a motor generator set, which is used either to charge the batteries or to actuate the control system. The master controller makes the proper connections by means of which energy from the storage battery actuates the valve magnets which control the action of the air-operated main contactors in the switch group, and the reversers. The controller handle is normally held in a vertical central position by springs, unless it is moved to one of the running points by the motorman. When released from the grasp of the hand, it flies to the vertical position, opening the circuit, and enabling the emergency application of the brakes by means of a brake relay valve alongside it. There are two holes in the face of the master controller, directly under the handle, and attached to the handle by means of a chain is a plug which may be inserted into either of these holes. The master controller is not operative unless this plug is pushed all the way into the lower hole, which closes the line switch, connects the generator and battery, and puts the brake relay valve into circuit. This is the ordinary running position of the plug. In case the line switch is opened by an overload, which generally causes the trolley to be lowered, the plug is taken out of the lower hole and placed in the upper, which action immediately closes the line switch, releases the trolley, and allows it to spring up against the wire. As soon as contact is made with the main circuit, the plug is taken out of the upper hole and replaced in the lower one.

There is a push-button on each side of the bottom of the master controller case. That on the right-hand side is used for lowering the trolley and opening the line switch. When the button on the left-hand side is pressed the switch group connection is stepped up to the last or high-speed notch and remains in that position until the handle of the controller has been returned to the off position.

There are four distinct notches on each side of the controller, the first corresponding to the coasting position with the main circuit open, the others enabling such gradations of speed as may be desired. Reversal is effected by moving the controller handle

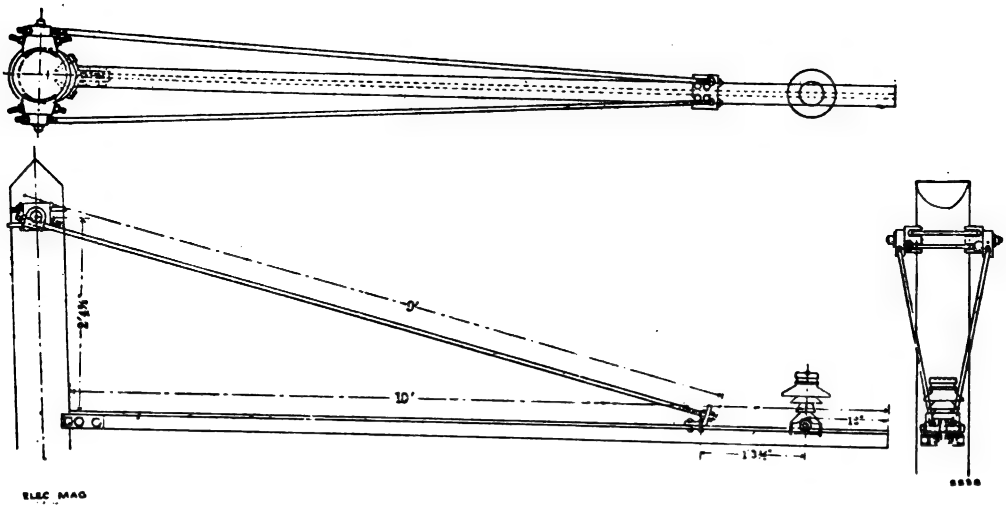


FIG. 2. DETAILS OF LINE BRACKET CONSTRUCTION.

to the opposite side of the centre or dead point. If the controller stops on the dead point, as it will if released by the hand, the brakes will be applied immediately.

The motor generator set is a compact machine of about one-sixth kilowatt, the motor being of the self-starting induction type, wound for 110 volts, the generator delivering normally about 23 volts. It is placed under one of the seats in the car, and is covered by a box with a removable lid, so that it can easily be reached for such small attention as it requires. It is mounted upon rubber bushings, and runs so quietly that its presence in the car can hardly be detected.

The storage battery consists of seven cells contained in a wooden box with handles, carried in an enclosed box underneath the car. No other auxiliary lines for any purpose are connected to the control circuit, in order to prevent it from being disabled by accidental grounds.

In one vestibule there is located, in an asbestos-lined compartment enclosed with steel doors, a slate switchboard panel upon which are carried all the switches and fuses for the control of the battery and motor generator set, the lighting circuits and heaters, and also the main connection from the low-tension side of the main auto-transformer o the auxiliaries.

The control circuit is fitted with junction boxes, branches running to receptacles at each of the four corners of the car directly under the end sills. The jumpers for connecting the cars and the receptacles are of the 12-point type, there being twelve wires in the main control circuit.

All the low-tension wiring between the transformer and switch group and motors is enclosed in a boxing of "Transite," to ensure its protection against mechanical injury, as the inductive effect of heavy currents renders the use of iron conduits impossible for this part of the wiring.

The overhead trolley construction, being the first of all catenary installations to operate at 11,000 volts, almost all the details had to be especially designed for this

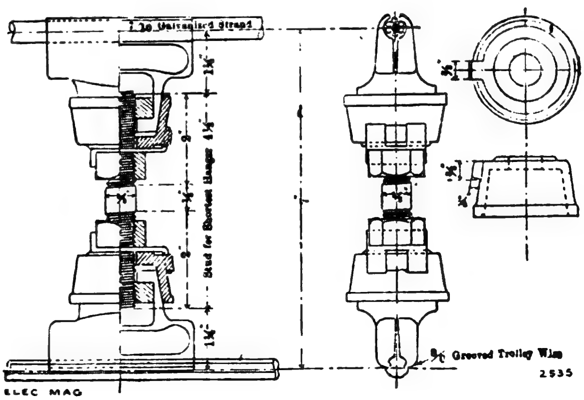


FIG. 3. DETAILS OF LINE HANGER.

equipment. Most of the work is of the side-pole and bracket type; the exceptions being at sidings and yards. A No. 4-0 grooved copper conductor is supported at intervals of 10ft. by hangers suspended from a seven-strand $\frac{7}{16}$in. steel "messenger" cable supported by the brackets. Each bracket (Fig. 2) consists of a 3in. by 2.5in. tee 10ft. long, the heel of which is fastened to the wooden pole by a pair of bent straps, the outer end being supported from the pole-top by two $\frac{5}{8}$in. steel truss rods. The insulator at each bracket is of the three-petticoat type, $6\frac{5}{8}$in. diameter by 6in. high, made in two parts held together by a quick-setting cement of litharge and glycerine.

On straight track the poles are placed at intervals of 120ft., but on curves the intervals are somewhat shorter. The maximum deflection from the centre line of the track on curves, is 7in. each way. The catenary hangers (Fig. 3) are of the Electric Railway Company's drop-forged type, being modified by the engineers to suit the requirements. The messenger clip and the trolley clip are of the same type, but grooved differently to accommodate their respective wires. They are joined by a $\frac{5}{8}$in. iron hanger-rod, with right-hand threads on each end, the longer rods being flattened in the middle to admit of bending them slightly, so as to conform to the divergence of the messenger and trolley wire near the ends of the spans. Both the trolley and the messenger ears are secured in position by lock-nuts. This type of suspension was developed especially for this installation, and is so constructed that there is no possibility of parts coming loose and falling apart on account of vibration. It is also very quickly and easily adjustable on the trolley wires.

The steady-strain rods, which are of treated wood, are mounted at one side of the bracket instead of directly underneath, in order to give sufficient clearance for the pantograph trolley on curves, where the super-elevation results in the tilting of the shoe from the horizontal. Each steady-strain rod is hinged to a spool-type Thomas porcelain strain insulator, which is clamped to one side of the bracket in such a manner that the hinged end of the rod is almost at the elevation of the top of the tee bracket. The method of attaching the steady-strain insulators to the bracket is such that they can readily be shifted along the bracket to follow up any change in alignment of the trolley wire that may be required by curvature or for any other reason. The clamps holding the steady-strain insulators are of 3in. by $\frac{3}{8}$in. bent iron. The spool-type insulators are cemented on to pieces of $\frac{3}{4}$in. pipe, through which passes the $\frac{5}{8}$in. eyebolt by means of which they are attached to the bent irons. Steady strains are used only on curves and turn-outs; they were not found necessary on tangent track.

The span construction is as nearly as possible similar to the bracket construction, the same type of pin and insulator being used. A 3in. by $2\frac{1}{2}$in. tee about 30in. long is suspended from the span wire by hangers of galvanized strand cable, adjustable in length, and fastened to the span wire cable by specially designed clips, the construction forming a sort of stirrup upon which the pin and insulator are carried. The messenger wire rests upon the insulator just as in the case of regular bracket construction. This form is used, not only for spans where there is only one track, but also in the yards, where three or four parallel tracks are electrically equipped. Span construction in general was used only where conditions absolutely required it.

For the extra long spans required where it was impossible to use guys of the ordinary type, it became necessary to employ a self-supporting span construction, and this was accomplished by installing the "Tripartite" type of steel pole, set in croncrete. This pole is constructed of re-rolled Bessemer steel rails, and it is less subject to rust, and consequently is more durable than any other available type of metal pole; moreover, all its surfaces are always open and are easily inspected. On account of the great tensile strength of the material, there is considerable saving in weight, and the fact that it was a standardized product, enabled quicker delivery to be made than though special riveted poles of structural steel shapes had been especially designed. The span wires consist of the regular messenger fitted with cable sockets sweated on at each end, the same being fastened to turnbuckles and pole collars at the tops of the poles. There are two span cables at each pair of poles, the upper one being used to carry the weight, the lower one acting to steady the arrangement and also serving as a relay in case of an accident to the upper span.

A very simple type of pull-off was devised for the curves in the span construction.

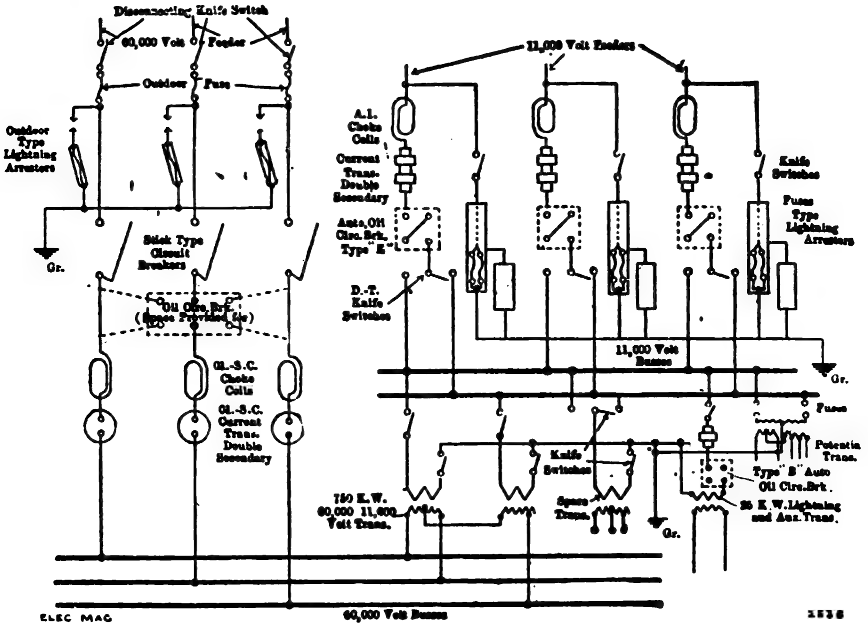


Fig. 4. Diagram of Connections in Transformer Sub-station.

The pull-off consists simply of a spool-type insulator, with a pipe cemented through the centre; the pipe is slipped over the hanger spacing-rod joining the messenger and trolley clips, thus giving an insulating connection through which an ordinary pull-off cable can be attached to both the messenger and the trolley wherever required. The division of the horizontal pull between the messenger and the trolley wire is easily adjusted to suit the conditions, by shifting the spool-type insulator up and down the spacing rod, by inserting longer or shorter nipples of pipe underneath it. In general, where it is near a span wire, the messenger cable is supported rigidly on its insulator and the trolley wire needs all the side pull; but in the middle of a span the pull must be equally divided between the messenger and the trolley wire.

The presence of several through-truss bridges over streams, and two low bridges, necessitated the employment of special construction at these points. The original clearances at one point were so low that the road-bed had to be excavated out and the track lowered about 2ft., the minimum clearance between the rails and the trolley wire being finally 18ft. The messenger is fastened to a horizontal spool-type insulator mounted at the centre of a substantial piece of turned oak, which is long enough to carry two more similar insulators, one on either side of the centre one.

The steel hangers reaching down from the overhead bridge structure carry the two side insulators, so that there are always two insulators in series between the 11,000-volt messenger cable and the steel parts of the bridge. These insulated supports are suspended at short intervals from the under side of the bridge, and are further supplemented by the use of steady strains which prevent any side displacement of the trolley wire. The shortest sizes of hanger spacing rods are used in such places. Where the bridge trusses are high enough to permit it, an iron stirrup is employed like that used in span work, which carries the standard form of straight line insulator, and the regular type of catenary suspension is employed.

The energy for operating the motor cars is transmitted at 60,000 volts from the Niagara falls station of the Ontario Power Company to a sub-station at Avon, about 19 miles south of Rochester. The sub-station equipment consists of three 750kw. single-phase, oil-insulated, water-cooled transformers. Two of the transformers are arranged for T-connection for changing the

three-phase current at 60,000 volts to two-phase current at 11,000 volts for the trolley circuits. The third transformer is held as reserve. The cooling water is circulated by gravity, the supply coming from the railroad company's water-tank system at the adjacent round house being pumped originally from the Genesee River about a mile distant.

The necessary transformation from three-phase to two-phase fits in very well with the natural subdivision of the line into two sections, one of which, to the south of Avon, is about 15 miles long, the other to the north being 19 miles long. The connections were therefore laid out to operate such sections upon separate phases of the two-phase system. One of the three secondary terminals is earthed at the rails: the two free terminals pass to the trolley sections and are protected by low equivalent lightning arresters reinforced by electrolytic lightning arresters. A set of call bells is provided so that, when the automatic breaker opens, a bell rings in the car inspection shed adjoining. Also, if the temperature of any transformer exceeds normal a bell circuit connected to a thermometer in the top of the transformer tank is similarly made to operate. The station itself does not require the continuous presence of an attendant, which is needed in the case of a rotary-converter sub-station. The working force is so organized that the car-repair men are always available for manipulating the sub-station circuit-breakers, and the cost of attendance is thereby reduced to a minimum.

The equipments were intended to be sufficient for operating single-car trains with one stop per mile, over the entire road, at an average schedule speed of 24 miles per hour, or to haul one trailer, making stops about 2½ miles apart at the same schedule speed. The company has furnished shelters where the public highways cross the line, there being 22 of these flag stations besides the regular intermediate way-stations, at which steam trains stop, 6 in all, or a total of 28 stations at which electric cars may be required to stop. Practically the electric cars stop at all the regular way-stations, but at only a portion of the flag stations. A single passenger coach is frequently attached to a motor car, and on some trains baggage, milk, or postal cars are regularly hauled. When two trailers are hauled two motor cars are required, making a four-car train. The service has proved immensely popular throughout the Genesee Valley, through which it passes, and it is intended to increase the number of motor cars for next season. It is found that the electric trains on the 34 miles of line can be depended on to keep to their running time rather better than the steam passenger and freight trains operating over the main line.—*Elec. World and Street Rly. Journ.*

FIG. 5. GENERAL VIEW ON ERIE RAILROAD, SHOWING OVERHEAD CONSTRUCTION, &C.

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

The Economy of the Tungsten Lamp.

A. A. WOHLAUER.

It is undoubtedly important for the illuminating engineer and central station man to have a clear conception of the conditions under which the use of the tungsten lamp is more favourable than that of other illuminants. Its long life and its high efficiency—three times that of the old carbon lamp—advocate its use; on the other hand it is fragile and its initial cost is great at present. A critical discussion, therefore, of the relations between the initial cost of the lamp, its life and its efficiency, price of energy, &c., will be interesting and useful. A formula may be used to calculate the effective or total cost of light production, C_c, per lamp-hour. This must take into account the initial or renewal cost, C_i, of the lamp per hour, and also the cost, C_e, of the energy consumed in the lamp per hour.

$$\text{Therefore—}C_c = C_i + C_e,$$

$$\text{and } C_i = \frac{P}{L}$$

where P represents the actual price of the lamp and L the average life of the lamp.

Now, if n = the number of candles per lamp, W = the specific consumption in watts per candle, and M = the cost of energy per kw.-hour, then

$$C_e = \frac{n \times W \times M}{1000}$$

and

$$C_c = \frac{P}{L} + \frac{n \times W \times M}{1000} \qquad (1)$$

is the formula for the total cost of light production per lamp-hour.

Another formula, derived herefrom, gives the total cost of light production, C_h, per candle-hour.

It is evident that

$$C_h = \frac{C_c}{n} = \frac{C_i}{n} + \frac{W \times M}{1000} \qquad (2)$$

This term, the candle-hour, appears to be of considerable importance for the central station man. As has been pointed out several times of late, the tendency in the policy of central stations is to furnish light rather than electricity to their customers, and to this end, they install lamps without cost. It is quite natural, therefore, that the charge should also be made for light and not for its equivalent in energy. If this were effected and if, for instance, the candle-hour or the kilo-candle-hour were adopted as unit, there can be no doubt that the lighting companies, far from fearing, would even welcome the advent of lamps of the highest possible efficiency.

Now, it is an established fact that low candle-power incandescent lamps of full voltage are more difficult to produce than lamps of higher candle-power. Not counting the price of the bulb, a 20c.p. lamp, for instance, is more expensive than a 100c.p. lamp. As, however, the public is not so easily persuaded to pay a higher price for a lamp of lower candle-power, it seems to be a good scheme to adopt the same price for all tungsten lamps ranging from 20 up to 100 candle-power.

This policy very probably will be adopted and a price of P=6s. 3d. ($1 50) can be used in the foregoing formula as reasonably

as one can quote for the old 16c.p. lamp a trade price of $P = 9$d. ($0.18).

The life of the tungsten lamp may for the present be valued as $L = 1000$ hours at a consumption of $H = 1$ watt per candle-power.

These last two values are not absolutely established as yet; they are, however, so near to the truth that they can be safely introduced in the formulæ.

With these three constant quantities—price, life, and consumption of the tungsten lamp—one can calculate the total cost of

TABLE I.—EFFECTIVE OR TOTAL COST OF LIGHT PRODUCTION PER LAMP-HOUR, INCLUDING COST OF ENERGY AND OF LAMP RENEWALS FOR TUNGSTEN LAMPS OF DIFFERENT CANDLE POWER AT VARIOUS ENERGY RATES.

	Rate per kw.-hour in cents.														
C.P.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	.16	.17	.18	.19	.20	.21	.22	.23	.24	.25	.26	.27	.28	.29	.3
16	.166	.182	.198	.214	.23	.246	.262	.278	.294	.31	.326	.342	.358	.374	.39
20	.17	.19	.21	.23	.25	.27	.29	.31	.33	.35	.37	.39	.41	.43	.45
25	.175	.2	.225	.25	.275	.3	.325	.35	.375	.4	.425	.45	.475	.5	.525
32	.182	.214	.246	.278	.31	.342	.374	.406	.438	.47	.502	.534	.566	.598	.63
40	19	.23	.27	.31	.35	.39	.43	.47	.51	.55	.59	.63	.67	.71	.75
50	.2	.25	.3	.35	.4	.45	.5	.55	.6	.65	.7	.75	.8	.85	.9
80	.23	.31	.39	.47	.55	.63	.71	.79	.87	.95	1.03	1.11	1.19	1.27	1.35
100	.25	.35	.45	.55	.65	.75	.85	.95	1.05	1.15	1.25	1.35	1.45	1.55	1.65

TABLE II.—EFFECTIVE COST OF LIGHT PRODUCTION PER CANDLE-HOUR, INCLUDING COST OF POWER AND OF LAMP RENEWALS FOR TUNGSTEN LAMPS OF DIFFERENT CANDLE POWER AT VARIOUS ENERGY RATES.

	Rate per kw.-hour in cents.														
C.P.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	.016	.017	.018	.019	.02	.021	.022	.023	.024	.025	.026	.027	.028	.029	.03
16	.0104	.0114	.0124	.0134	.0144	.0154	.0164	.0174	.0184	.0194	.0204	.0214	.0224	.0234	.0244
20	.0085	.0095	.0105	.0115	.0125	.0135	.0145	.0155	.0165	.0175	.0185	.0195	.0205	.0215	.0225
25	.007	.0008	.009	.01011	.011	.012	.013	.014	.015	.016	.017	.018	.019	.02	.021
32	.0057	.0067	.0077	.0087	.0097	.0107	.0117	.0127	.0127	.0147	.0159	.0167	.0177	.0187	.0197
40	.00475	.00575	.00675	.00775	.00875	.00975	.01075	.01115	.01275	.01375	.01475	.01515	.01675	.01775	.01875
50	.004	.005	.006	.007	.008	.009	.01	.011	.012	.013	.014	.015	.016	.017	.018
80	.00287	.50039	.0049	.0059	.0069	.0079	.0089	.0099	.0109	.0119	.0129	.0139	.0149	.0159	.0169
100	.0025	.0035	.0045	.0055	.0065	.0075	.0085	.0095	.0105	.0115	.0125	.0135	.0145	.0155	.0165

TABLE III.—TOTAL COST OF LIGHT PRODUCTION PER LAMP-HOUR OF CARBON AND GEM LAMPS AT DIFFERENT RATES OF ENERGY.

Lamp.	Rate per kw.-hour in cents.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Carbon	.086	.136	.186	.236	.286	.336	.386	.436	.486	.536	586	.636	.686	.736	.786
Gem .	.096	.146	.196	.246	.296	.346	.396	.446	.496	.546	.596	.646	.696	.746	.796

TABLE IV.—TOTAL COST OF LIGHT PRODUCTION PER CANDLE-HOUR FOR CARBON AND GEM LAMPS AT DIFFERENT ENERGY RATES.

Lamp.	Rate per kw.-hour in cents.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Carbon	.0054	.0086	.0116	.0147	.0178	.021	.024	.0272	.0305	.0335	.0365	.0395	.0425	.0455	.0485
Gem .	0049	.0072	.0097	.0123	.0148	.0173	.0198	.0223	.0247	.0273	.0298	.0322	.0348	.0373	.0398

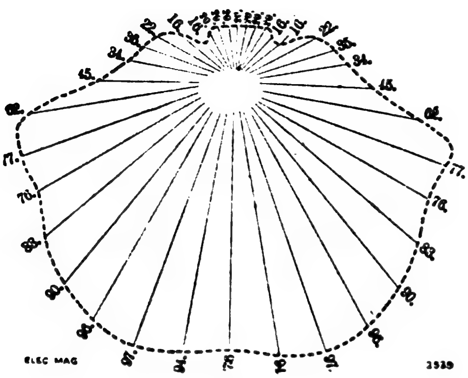


Fig. 1.

light production per lamp-hour and per candle-hour. The results are given in Tables I. and II.

For comparison the total cost of light production may be calculated also for the old carbon lamp of 16 candle-power and for the graphitized filament or Gem lamp of 20 candle-power.

The price of the carbon lamp is given as 8d. (16 cents.); its consumption, $H_c = 3.1$ at a life of $L_c = 450$ hours. The price of the graphitized filament lamp is 10d. (20 cents.) and its consumption is $H_m = 2.5$ at a life of $L_m = 450$ hours.

It is evident that, in the tables, the low energy rates refer to the cost of generating electricity, whereas the high rates refer to the selling price. In this regard the results of the calculations as reproduced in the different tables reveal that the candle-hour of the tungsten lamp is cheaper than the candle-hour of the old carbon lamp and of the metallized filament lamp for energy rates ranging down to 2d. (4 cents.) per kw.-hour.

For this reason it would be of economical interest to the general public as well as to a number of isolated plants to substitute, at their own expense, for each carbon lamp a tungsten lamp of equal candle-power. As an example, at the usual rate of 5d. (10 cents) per kw.-hour the saving per lamp would amount to about 40 per cent. A still greater saving could be effected by substituting for a number of carbon lamps one tungsten lamp equalling in candle-power the total candle-power of the carbon lamps.

As an illustration, the economy in using one 50c.p. tungsten lamp in connection with a Holophane hemisphere and reflector, instead of a cluster with four 16c.p. carbon lamps with an opal reflector, would be about 70 per cent. Regardless of the economical considerations, the tungsten lamp as used above would also present a more artistic appearance. The photometric curves published in Cravath and Lansingh's book on "Practical Illumination" (Fig. 151 and Fig. 170), and reproduced in Fig. 1 and Fig. 2, show that the light distribution is practically of an equal efficiency. It is assumed that the light distribution will not be noticeably affected by the substitution of a 50c.p. tungsten lamp for a 50c.p. carbon lamp in Fig. 2.

In cases such as the one under illustration even the central stations, generating the electricity at a cost of ½d. (1 cent) per kw.-hour, would be able to produce a cheaper candle-hour for their own use with the tungsten lamp than with the carbon lamp.

Due to such economical features as the above, and also due to the fact that the price of the tungsten lamp will probably not be reduced in the near future, it would be advisable for the lamp manufacturer to consider only the introduction of high candle-power tungsten lamps of about 32 to 40c.p. This would also entail the advantage for the central station that whereas the use of 16c.p. tungsten lamps instead of 16c.p. carbon lamps would involve a loss of 67 per per cent. due to decrease of the energy consumed, the use of 32c.p. tungsten lamps instead of 16c.p. carbon lamps would mean a loss of only 30 per cent.

As to the public, the lamp-hour of a 32c.p. tungsten lamp would cost not more than the lamp-hour of the 16c.p. carbon lamp or the lamp-hour of the graphitized filament lamp, as indicated in Tables I. and

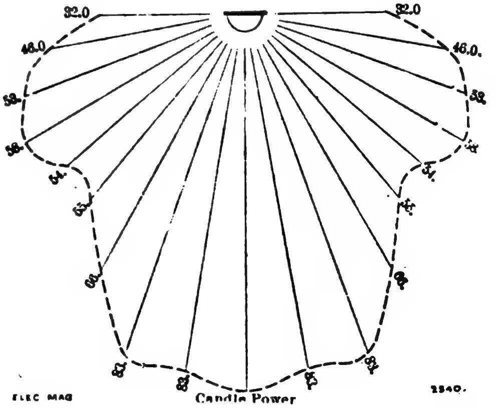


Fig. 2.

III. It would, therefore, not involve higher expense for the general public, if it would replace one 16c.p. carbon lamp with a 32c.p. tungsten lamp, even if the 16c.p. lamp would give sufficient illumination for the special purpose.

In such cases, however, where the cost of the kw.-hour is less than 2d. (4 cents), it would not be advantageous to substitute a 32c.p. tungsten lamp for a 16c.p. carbon lamp on account of the high price of the lamp, as given above, whereas a 32c.p. tungsten lamp may very well be used in place of two 16c.p. or one 32c.p. carbon lamp with the same economy as heretofore cited.

It would be of interest, however, to consider how much the tungsten lamp ought to be reduced in price to make it desirable to consumers who pay less than 2d. (4 cents) per kw.-hour for their energy. This price X can be derived by employing formula 1 in connection with the following considerations: In order to know the highest price of the tungsten lamp to be granted, the cost per lamp-hour of a 32c.p. tungsten lamp, for instance, should be equal or less than the cost of the 16c.p. carbon lamp at a certain rate of energy.

Employing, then, formula 1 and using the values decided on above for life, consumption, &c., we can solve the above expression for X, assuming, for instance, a rate of 2 cents per kw.-hour. This results in

$$\frac{16}{450} + \frac{50 \times 2}{1000} \gtreqless \frac{X}{1000} + \frac{32 \times 2}{1000}$$

and

$$X = 72 \text{ cents (3s.)}.$$

This, therefore, is the price that the tungsten lamp most likely will have to be reduced to in order to meet all the demands.

All these calculations hold good assuming that the power stations follow the policy of furnishing electricity and do not supply the lamps to their customers, and that these lamps be paid for by the consumers, in spite of which fact it has been shown that the general public will derive great benefit from the tungsten lamp.

The position of the central stations toward the tungsten lamp cannot be such a favourable one, as far as the use of the lamps for themselves and the sale of electricity is concerned. Although it is beyond doubt that an improvement such as the tungsten lamp will increase the number of customers for the central stations and finally raise their total output tremendously, the fear is not unfounded that for some time to come the load of the individual customer may decrease.

However this may develop, the adoption of the candle-hour will do away with all these fears and the general public as well as the central station would share the benefit of the new lamp.

Though the introduction of the candle-hour rate would offer great advantage over the kw.-hour rate, several difficulties may present themselves in its adoption and execution. One of the problems — the measuring of the candle-hour, which appears to be one of the most difficult ones— could be solved in a rather simple manner. Taking for granted that in the tungsten lamp one watt produces one candle, then one watt-hour would equal one candle-hour, and one kw.-hour one kilo-candle-hour. Therefore, by changing the "watts" into "candles" on the meters, the measurements could be effected without any change in the construction of the meters.

In view of the price of the kilo-candle-hour this could be determined by starting from the following points: It has been calculated that the lamp-hour of the 16c.p. carbon lamp costs about as much as the 32c.p. tungsten lamp, including charge for renewals. As shown by the tables, the carbon lamp-hour costs about ¼d. (0.5 cent) at a rate of 5d. (10 cents) per kw.-hour, while the tungsten lamp-hour of 32c.p. costs a little less at the same rate.

This price of about ¼d. per lamp-hour could be adopted as a basis for a new light rate, the central stations renewing the tungsten lamps free of charge in pursuance of the policy to furnish light and not power and supplying their customers exclusively with 32c.p. tungsten lamps for reasons discussed above.

To calculate the new light rate, the following formula can be used:

$$C_1 = \frac{n \times r}{1000} \qquad (3)$$

wherein

C_1 represents cost of lamp-hour.
n candle-power of supplied lamps.
r rate or price per kilo-candle-hour.

Basing upon the above assumptions the

central stations will feel justified in making a charge of

r = 8d. (16 cents) per kilo-candle-hour.

The consumer who is not inclined to pay high prices for light bills will find at the end of the month that his light bill is not larger and that under the new rate he is receiving more light for the same or for a lower amount. Thus, while the consumer profits by the use of the candle-hour system, the central stations do not lose by it. They get 3d. (6 cents) more for the kilo-candle-hour than they received for the kw.-hour at the old rate. That means 6 times 32 or 8s. 2d. ($1.96) for each lamp. While the central stations furnishing the lamps free of charge still make an additional profit of at least 1s. 11d. (46 cents) on each lamp, the consumer pays now 8d. (16 cents) per kilo-candle-hour instead of about 1s. 3d. (30 cents) as heretofore.

Two things, however, have to be carefully considered in connection with the new light rate; these are the fragility and the life of the tungsten lamp as made at present.

Due to the fact that the tungsten lamp is more fragile than the carbon lamp, it is absolutely necessary that the same be handled with considerable care and that the central station insure themselves against unreasonable claims by establishing rules, for instance, to prevent the use of drop lights with key sockets, &c.; although, according to the author's experience, the tungsten lamp can very well be used with drop light with key socket for more than 1000 hours, if reasonable care is observed.

As to its life, it has been pointed out that so far as determined the average life of the tungsten lamp is about 1000 hours, although this fact has not been exhaustively investigated; but the work that has been done along that line reveals that one watt per candle-power or even somewhat less would guarantee the above life as the most economical of the tungsten lamp.

Small overloads due to overvoltage do not affect the life of the tungsten lamp as much as the carbon lamps due to the positive temperature coefficient of the metal. While this is another advantage of the tungsten lamp, experience shows that in spite of the positive temperature coefficient, low periodical fluctuations of the voltage are more noticeable in the tungsten lamp than in the carbon lamp, very likely due to the higher intensity of light or intrinsic brilliancy per unit of the light-giving body. —*Elec. World.*

Automatic Slip-Regulators.

For use with Variable-speed Induction Motors up to 1200h.p.

When variable-speed induction motors are used to drive machinery in which the load fluctuates between almost zero and twice or three times the average load—as, for example, in continuous-running rolling mills—some means is desirable of equalising the demand upon the transmission lines, or of minimising the kilowatt-capacity of the generating station and the size of motor required. This may be partly done by providing a flywheel on the shaft of the motor, but the drop in speed of this type of motor between no load and full load is so slight that a very large flywheel would be necessary to give any equalising effect; nor is the effect complete, since any variation in speed causes a variation in the current taken from the line.

In order to completely equalise a fluctuating load with a comparatively small flywheel, the Westinghouse automatic slip-regulator has been designed.

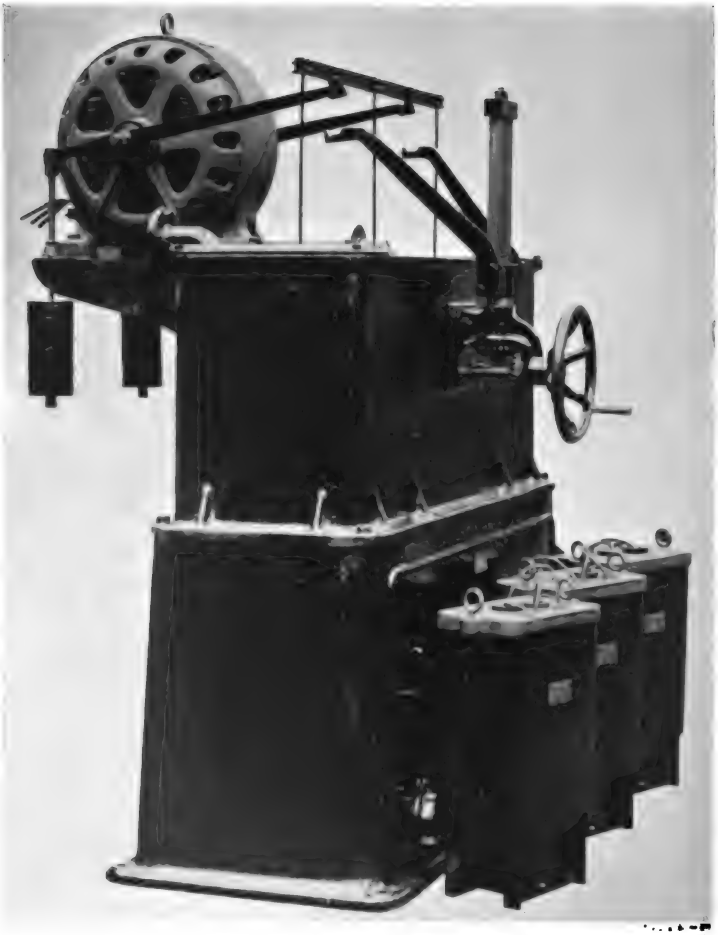
This device consists of a liquid resistance, connected in the rotor circuit of the motor, and which is automatically varied by a motor magnet in such a manner that any tendency towards increase of current in the line increases the resistance in the rotor circuit, and *vice versâ*. In the first case, as the load increases, resistance is inserted in the rotor circuit of the motor, and the latter tends to slow down. The excess load is then taken up by the flywheel, which, in parting with some of its stored or potential energy, also decreases somewhat in speed. When the load falls off, the current taken from the line tends to decrease, resistance is cut out of the rotor circuit, and the motor attains full speed and restores to the flywheel the energy lost during the period of overload. This energy, it will be evident, is stored during periods of light load.

By the above means the torque of the motor, and, consequently, the current drawn from the supply mains, are kept approximately constant throughout the run, and as

the generator supplying power and the motor are, therefore, relieved of all overload, they are smaller and operate at greater efficiencies than would be the case were a slip regulator not used.

The liquid resistance is provided with cooling coils for cold water circulation in order to carry off the heat.

The general construction and arrangement of the apparatus is evident from the illustration. The slip-regulator is provided with a wheel for hand operation, in which manner the motor is started in the first instance.



Westinghouse Automatic Slip-Regulator.

Powers Required to Drive Machine Tools.

Drills.	H.P.
Sensitive Drills	¼
12in. to 20in. upright drills	1
20in. to 24in. upright drills	1½
26in. to 30in. upright drills	2¼
30in. to 40in. upright drills	3½
36in. to 40in. radial drills	1¾
4ft. to 5ft. radial drills	2
6ft. to 8ft. radial drills	3 to 5

Lathes.	
Speed lathes	1
22in. and 24in. engine lathes	2
26in. and 30in. engine lathes	2½
36in. and 42in. engine lathes	3½
48in. and 54in. engine lathes	5
60in. engine lathes	6
72in. engine lathes	7½
84in. engine lathes	10

Heavy-duty Lathes.	
24in. to 30in. lathes	15
36in. to 48in. lathes	20
54in. to 72in. lathes	25

Boring Mills.	H.P.
37in. boring mill	4
51in. boring mill	5
5ft. boring mill	6
6ft. boring mill	7½
7ft. to 9ft. boring mills	10
10ft. boring mill	12
12ft. to 16ft. boring mills	15
16ft. to 25ft. boring mills	18

Planers.	
20 × 20in. × 6ft. single-head planer	3½
30 × 30in. × 8ft. single-head planer	5
42 × 42in. × 10ft. single-head planer	7½
60 × 60in. × 12ft. double-head planer	10
72 × 72in. × 14ft. double-head planer	15
84 × 84in. × 18ft. double-head planer	20
9 × 10 × 24ft. double-head planer	30
12 × 12 × 24ft. double-head planer	40

Shapers (Single-head Machines).	
16in. stroke	2
24in. stroke	3
30in. stroke	5

—*American Machinist.*

Every aspect of the design and manufacture of electrical apparatus is dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

Artificial Loading of Large High-Voltage Generators.

N. J. WILSON.

THE apparatus required for artificially loading large high-voltage generators is so much subject to conditions existing on the site at which the generators have to be tested, that it is more or less impossible to lay down any hard and fast rules to work upon when full-load tests on such machines have to be carried out. If it is possible to run an auxiliary plant such as rotary converters or motor generators fed through static transformers from the main generator, a steady load can readily be obtained by loading up the auxiliary plant on water tanks such as are frequently used for voltages up to 2000. For taking steam consumption tests on steam-driven electrical plants, however, it is preferable wherever possible to load the generator on a direct non-inductive resistance. For voltages from 6000 to 12,000 volts it is generally admitted that the only practical form of resistance which can be used is the purest water obtainable, and it is owing to the great difference that exists in the conductivity of the water available at different places that the chief difficulty is found in determining the size of apparatus required. The chief points to be taken into consideration in designing such apparatus are as follows:

The electrical resistance of the water available for use; the amount of water supply available; means of saving water used throughout the test; the regulation to be obtained when working; lastly and most important—absolute safety to the tester who has to operate the apparatus adopted.

The first two of these items determine the dimensions of the tanks to be used, and upon these in turn depend to a great extent the regulation to be obtained under working conditions. For instance, the first item fixes the voltage which can be safely put across the electrodes in the tank, and the second item controls the amount of energy which can be absorbed by the tank. Again, it is obvious that the higher the temperature at which the water in the tank is worked, the greater the energy absorbed. Care has to be taken, however, to keep this temperature as constant as possible in order to ensure obtaining a steady load, and in practice it is found that it is best to work the water at such a temperature as will prevent the formation of vapour. The last item—the safety of the tester while using the tank—brings one to the consideration of the material to be used in its construction. In this connection it may be mentioned that wooden tanks have been used from time to time, but they give trouble on high voltages. The saturated wood allows the current to flow through it in parallel with the water, and in consequence the wood is first charred and then set on fire. Another disadvantage is that the tester is liable to receive shocks.

For the latter reason alone, therefore, it is best to use material that can more readily be satisfactorily earthed. By way of illustration —the following account of an attempt to artificially load up a 5500kw., 11,000-volt, three-phase turbo-generator at the Chelsea power station of the District Railway Com-

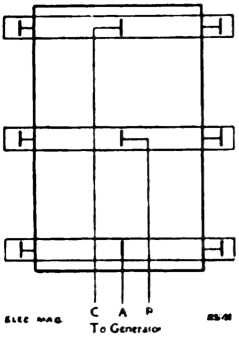


FIG. 1.

pany may prove of interest. The apparatus consisted of three wooden tanks connected as shown in Fig. 1, the regulation of resistance being obtained by means of different water levels. Other methods for regulation, such as by moving plates closer together and also by varying the surface of electrode under water without altering the water level, can be used, but the rig required becomes somewhat complicated. Each tank had three electrodes, the live electrode being in the centre and two other neutral electrodes at the ends of each tank. All the neutral electrodes were connected together and joined to the star point of the generator, which was earthed. It will thus be seen that with 11,000 volts on the generator there was a potential of about 6300 volts between the live and neutral electrodes in each tank. A continuous stream of water was kept running through each tank.

It was found that, however carefully insulated the live plates were from the woodwork of the tanks, after the voltage has been on for a short time, the sides of the tank nearest the centre began to fire, clearly indicating that the current was leaking along the wood. To prevent this, the sides and bottoms of the tanks were lined with glass, the joints being cemented. This answered all right until the water got through the joints and again caused firing of the wood. As it was found very difficult to get these joints to stay watertight the whole scheme had to be abandoned. The internal dimensions of these tanks were about 17.5ft. long by 1.25ft. wide by 2.5ft. deep. The maximum load obtained on them was 3000kw. at 11,000 volts, and with this there was considerable firing of the wood, rendering it impossible to keep the load on for any length of time. The reason for the live plates being placed in the centre of the tanks and the neutrals at the ends, was to make the apparatus safer for the tester.

Had only two plates been used, namely, one live and one neutral plate, it would have caused the three streams of water at one end of each tank to have a potential of 11,000 volts between them, thus rendering it dangerous for those in the close vicinity. These three wooden tanks were afterwards replaced by a single iron tank 15ft. in diameter by 10ft. deep. Water inlets were placed at the bottom of the tank at three points right under the position of the three live electrodes, and also an inlet was placed in the centre with a continuation pipe to allow cool water to be supplied to the top of the tank in order to assist in keeping down the formation of vapour. The tank was also provided at the top with four outlet pipes and at the bottom with a drain pipe for emptying when necessary. The arrange-

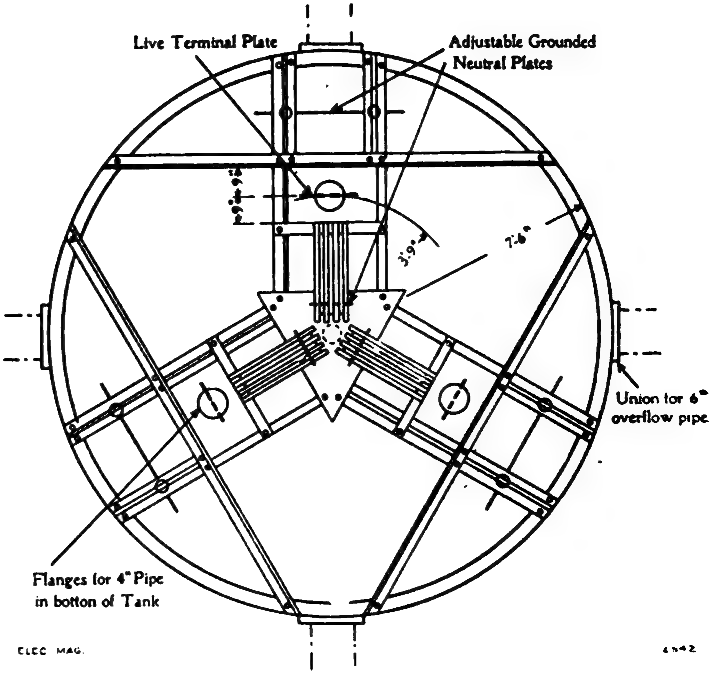


FIG. 2.

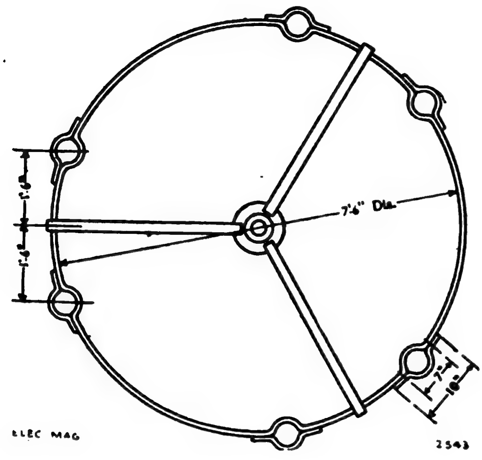


FIG. 3.

ment originally provided for electrodes is shown in Fig. 2; from this it will be seen that the neutral electrodes could be moved nearer to the live electrodes by moving them along the slides provided for this purpose. They were all earthed substantially to the framework of the tank, which in its turn was connected to the neutral point of the generator, thus rendering it impossible to get shocks from the side of the tank. The three live plates are suspended from a wrought-iron ring as shown in Fig. 3. The method of insulating these suspended plates is shown in Fig. 4. From this it will be seen that double rows of high-tension insulators come between the metal ring and the live plates; the former, of course, is earthed, thus preventing any possibility of the tester receiving shocks when lifting or lowering the live plates by means of the rope attached to the hanging element.

After a preliminary run, it was found that the town water supply, which was the purest available, was of such a resistance that neutral plates were not required at all to obtain the loads. Again, with the live plates as at first used, full load current was obtained with only 8000 volts on the generator. To overcome this the plates were reduced in size, till finally in order to get the full voltage on the tank and at the same time keep the current down, rods of copper were tried as electrodes. This expedient naturally meant that the current density was increased to such an extent in these electrodes that excessive arcing took place both under and at the surface of water. To do away with this arcing it was necessary to use larger electrodes and this could only be done when the resistance of the path between the live electrodes was increased. To do this, the idea was tried of placing 12in. terra cotta pipes about 8ft. high under the electrodes, the top of these pipes coming about 2ft. below the surface of the water, the bottom of these pipes resting on the base of the tank. This had the effect of cutting down the cross-section of the water between electrodes and so increased the resistance of the path.

With this arrangement the larger electrodes were again used and worked quite satisfactorily at 11,000 volts. The increased section of the electrodes, together with the fact that cool water was kept entering the tank at the bottom of each of the terra cotta pipes, kept down any tendency to arc on the heavier loads. By reducing the height of the pipes by quite a small amount, such as one foot, the load which the tank would take was increased a great deal, as the resistance of the path between the electrodes was thereby rapidly reduced. With water having a resistance such as that of Manchester or Yoker, as shown in Table I., such an expedient would not have been

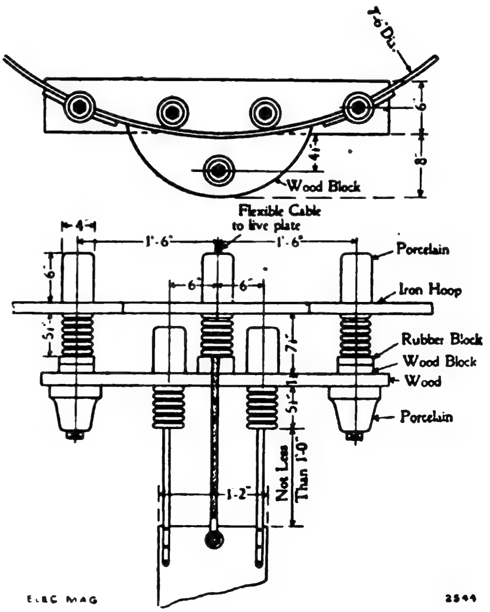


FIG. 4.

necessary. With this tank, loads up to 8000kw. at 11,000 volts could be obtained by increasing the size of the electrodes. A small motor was rigged up to drive a pump for circulating the water. After going through the tank it was again used as feed water, although when the tank was taking heavy loads it was found impossible to save all of it in this way.

The results of an analysis of the various waters used in the test is given in Table 1. The comparative resistance tests were all taken under similar conditions and serve to show the variation in water obtainable, and the consequent difficulty when worse specimens only are available. For instance, in the testing department at the Westinghouse Works, Manchester, with a tank 8ft. in diameter by 5ft. deep, when used with the well water given in Table 1, it was found impossible to get 1000 volts across the electrodes without an excessive current flowing, whereas, with the Manchester town water, loads up to 2500kw. at 9000 volts could be absorbed with only a 2in. water supply. It will be seen from Table I. also that the town water was found to have a resistance thirty times greater than that of the well water. Again, at the Yoker and Motherwell power stations of the Clyde Valley Power Company, brick tanks were constructed below ground level for testing the 1100 volt turbo-generators. These tanks were 15ft. in diameter by 5ft. deep, and they were found to work quite satisfactorily, without any of the difficulty experienced at Chelsea, owing to the much purer water supply.

TABLE I.

Impurities found by Analysis.	Grains per Gallon.				
	Manchester Well Water.	Manchester Town Water	Chelsea Town Water.	Yoker Town Water.	Clyde River Water Motherwell.
Total solids ..	115.64	4.92	16.30	3.36	12.95
Inorganic solids non-volatile ..	1.4	3.86	..	1.96	..
Organic matter	114.24	1.06	2.38	1.40	..
Silver	.98	.19	.488	.11	.78
Iron (Fe_2O_3) ...	.9	..	.456	.33	.47 (Fe_2O_3) (Al_2O_3)
Lime (CaO) ..	.67	.28	4 620	.28	2.43
Magnesia (MgO)	.38	.15	.56	.19	1.54
Sodium chloride (NaCl) ..	88.9	1.38	2.765	.78	..
Carbon dioxide	..	..	1.729	..	..
So_3	..	..	4.508	..	1.19
Na_2O	9.59	..	..	..	..
Comparative Electrical Resistance* ..	1	30	6.8	37	48

* These results are expressed taking figures obtained for Manchester well water as a unit, this being the most impure tested.

In conclusion, there are a few necessary precautions which should be taken before attempting to take a full-load run on artificial load on a high-voltage generator, viz.:

1. Earthing of all instrument cases in the circuit, so that testers cannot get shocks therefrom.

2. Thermometers on various parts of the generator windings should be tied firmly in such a way that they can be read throughout test without any necessity for handling them.

3. The rig for hoisting the hanging element should be examined before the test to see that it works freely, and stops should be placed so that the plates cannot be accidentally overwound, or drop to the bottom of the tank.

4. The insulators on the hanging element should always be examined and thoroughly cleaned before a test. As these are often in the open air, they are very apt to become dirty, and if not cleaned, discharges may take place, causing them to crack, and necessitate the shutting down of test.

5. Careful observation of the operation of the tank lest circulating water supply should suddenly fail, in which case the time taken to greatly increase the load is so short that arcing on the electrodes commences, which may end in a bad short-circuit on the tank.

6. Means of communication between the testing-tank, switchboard and the man running the turbine or engine, so that in such an emergency as just mentioned the load may be quickly reduced or taken off altogether if necessary.

7. A complete set of isolating switches should be placed between the main switchboard and the tank, so as to cut the latter completely out of circuit when required.

8. A careful examination should be made to see that the earthing arrangements made for the neutral point of the generator and also for the testing-tank are adequate and satisfactory.—*Elec. Journal.*

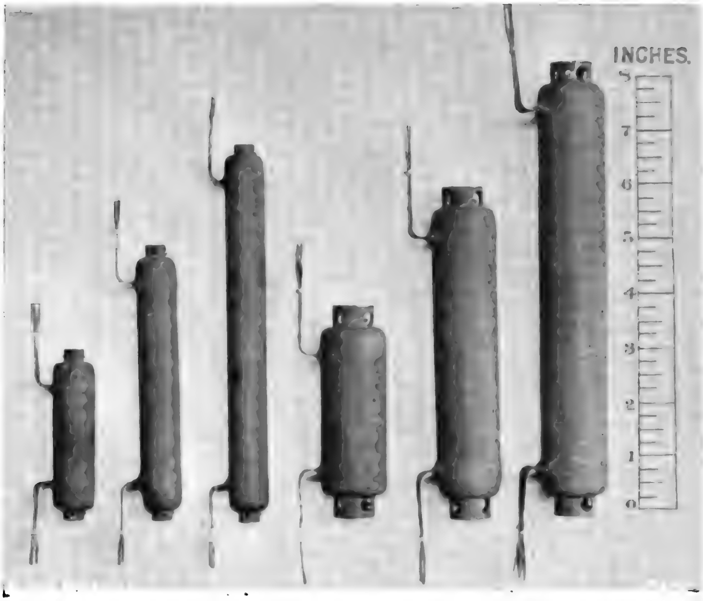


Fig. 1. Embedded Type of Resistance Units.

Embedded Resistance Units.

Though modern electrical apparatus must be compact as well as efficient, there has been much difficulty in procuring at reasonable cost a form of resistance less bulky than those in general use. Even the smallest resistances are invariably mounted on massive frames, a number of which, should they be used together, occupy in many cases much valuable space.

Different types of small and compact resistance units have from time to time appeared on the market, but there have not been many details of their construction published, nor is much information available regarding them. The following particulars on one of the most notable of these recent types of compact resistance units should prove of interest. The units herein described and illustrated are claimed to withstand very high temperatures without deterioration and are suitable for both a.c. and d.c. circuits.

As will be gathered from Fig. 1, the units are divided into types according to length and diameter, each type having a considerable range of current-carrying and resistance capacity. The resistance capacity for the various units ranges from 0.033 ohm to 7800 ohm, and the continuous-current carrying capacity from 0.08 amp. to 44amp. It should be noted these current capacities are continuous; that is, they represent the maximum values which the coils will accommodate for an indefinitely long time; naturally, for intermittent services the current capacities may be rated much higher.

The resistance conductor is mounted on a split tubular steel core with perforated ends for ventilation. The core is first coated with a layer of hard enamel, and above this with a layer of special composition. The resistance wire is then wound on, and a final coating of composition applied. The temperature co-efficient of the resistance wire is practically nil.

The resistance wires are efficiently secured to the terminal lugs without the use of solder; the lugs being of a specially pliable

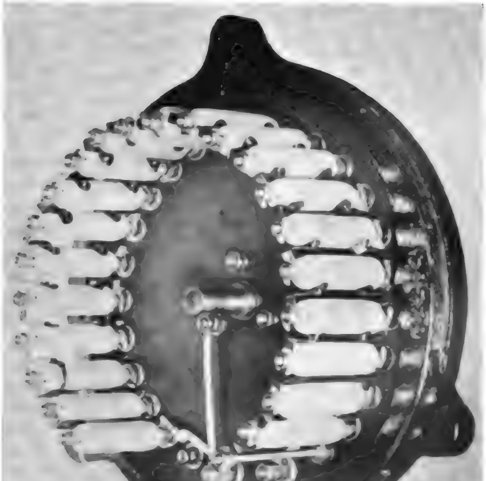


Fig. 2. Rheostat built up of Resistance Units.

metal suitable for withstanding a large amount of bending.

The uses to which these resistance units are applied are manifold, the chief being as follows: For field rheostats; motor-starting rheostats; current-regulating purposes generally; controllers; the shunt circuits of circuit-breakers; arc-lamp resistances; mercury-vapour lamp resistances; field discharge switches; instrument resistances; radiators and other forms of electric heating apparatus; telegraph work; telephone work; testing and laboratory work; &c.

They are made as a standard product by the British Westinghouse Company, Ltd., who claim the following as the chief advantages of these highly perfected electrical accessories:—

(*a*) The material of which they are constructed makes them suitable for any temperature up to 563deg. F.; they are consequently very suitable for electric radiators, &c. They are considerably more compact than open spirals or tubes. The insulation between the resistance wire and steel core is practically indestructible, and is tested with high alternating-current voltage; the resistance wires are adequately protected from corrosion; the units are waterproof and fireproof; they are of great strength, and can be handled without fear of breakage; they are furnished with two or more terminal lugs according to capacity; connection leads are rarely required; the resistance is practically constant whatever the temperature.

For rheostat work the units offer many advantages, among which are: Space occupied is about one-third that necessary for open spirals and tubes; absence of connection leads, the connection lugs of one unit being clamped to the supporting rod of the next; the resistance wires are hermetically sealed, and are not liable to corrosion; the insulation resistance is extremely high; each unit is independent, and can be replaced without difficulty in a few minutes.

In field rheostats and regulating resistances generally, the units are arranged as shown in Fig. 2. For starting rheostats and other work where the units are for intermittent service, the temperature rise allowed for on the surface of the units is about 190deg. C. after several starts have been made at intervals of fifteen minutes.

The above particulars are sufficient to show that the range of adaptability of these resistance units is practically unlimited.

REAR VIEW OF WESTINGHOUSE SWITCHBOARD IN COURSE OF ERECTION.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

The Moore Light and Illuminating Engineering.

W. P. DICKSON.

As the science of illuminating engineering becomes more fully recognised as a necessity in the present-day increase in the use of artificial illuminants, the change in attitude toward the more common forms of lighting will be more evident than at present. Greater attention will be paid to the means toward securing such distribution of light as will give a soft diffused effect producing a result similar to daylight filtered through a skylight. Many efforts are already being used to that end, such as "cove-lighting," diffusing shades moulded according to laws of reflection, artificial light through a skylight, reflecting shades, using the ceiling as a secondary reflector, and so on. All of these methods show praiseworthy efforts toward avoiding the glaring spots of light so offensive to the harmonious arrangement of a well-planned room. A source of light, too, must be such that being near it will not cause fatigue to the eye nor give the impression of deeper darkness beyond the radius of illumination. For these reasons hot wire or carbon lamps giving a brilliant light cannot in actual use approach the ideal illuminant, since to render them usable they must be enclosed in ground glass, porcelain or other softening shades. The demand for better diffusion with lowered cost of operation would appear to be theoretically and practically met by the vacuum-tube system of illumination as invented and perfected by Mr. D. McFarlan Moore, the pioneer in the field of commercial vacuum-tube investigation. Briefly, an installation consists of a long glass tube $1\frac{3}{4}$in. in diameter, and of a length varied to suit the space to be illuminated. The tube is suspended from either the ceiling or the side walls by simple ring fixtures. The two ends of the tube terminate in a steel box containing a step-up transformer and a solenoid for automatically operating the feed-valve or life-renewing element. The greatest obstacle to a successful vacuum-tube has hitherto been the fact that after a few hours of life the resistance of the partial vacuum has become so great as to cause a spasmodic flickering and dying out of the light, and until the sensitive adjustment of the feed-valve as used by Mr. Moore was invented, no successful commercial vacuum tubes were possible. The final difficulty having been thus surmounted gives to the tube an indefinitely long life, thereby placing the Moore light in the unique position of requiring no renewals.

The tube may be so placed as to conform to the shape of space to be lighted, there being no difficulty in forming angles or corners in the tube.

The air being drawn from the tube until a high vacuum is obtained, the ordinary low-voltage alternating-current leads are connected to the small transformer, the higher potential leads being connected to the terminals of tube proper.

The small quantity of air remaining in the tube becomes luminous on closing the switch, since it acts as a conductor between the high-pressure terminals. The whole length of tubing sheds a soft uniform light,

perfectly steady, and of the lowest intrinsic brilliancy of any artificial illuminant. The perfect diffusion renders the light almost shadowless, an advantage appreciated in every line of work for which it may be used. As the light given by the Moore tube varies inversely as the distance, the effect obtained is the most economical known. The question of cost to a merchant is not so much what efficiency of watts per candle is obtained as it is how much useful light he has for lighting his goods or display tables, giving his customers a comprehensive view of his stock, and the clerks sufficient light for displaying goods to the best advantage. In the great field of general illumination the Moore light will be found to be by far the most economical and satisfactory for every requirement as outlined above, and gives the illuminating engineer the advantage of an ideal illuminant, embodying all the features so earnestly sought by the man of science.

Comparative Cost of Cooking with Various Fuels.*

The results set forth in the table on the following page show the relative average expenses of cooking by electricity compared with the different fuels in use, for the same kind and character of cooking operations, the time in each case being based on one hour.

From the results tabulated the advantages and disadvantages of cooking by electricity may be summarized as follows: at the rate of twopence per kilowatt-hour it would cost double that of gas fuel. This fact, together with the initial cost of the apparatus required, would appear to forestall its general adoption at present. While the first cost of cooking utensils seems high, yet an outfit may be obtained for £10 ($50) consisting of an oven, a broiler, a griddle, a 6in. stove, and a flat-iron; or the following combination: A griddle, two 6in. stoves, an oven, and a flat-iron. Either of these outfits would serve for the necessary cooking for an ordinary family of from three to six people. A very complete outfit, comprising a slate-top table with several outlets for electrical connections with cords and conductors and the following utensils: an oven, a broiler, two stoves, a coffee percolator, a quart pot, and a large kettle may be purchased for £23 ($110). This is not so much in advance, therefore, of the ordinary kitchen outfits as it might appear. Moreover, these cooking vessels are of nickel-plated copper, which is of longer life and is more easily kept in good order than are ordinary utensils. Those utensils that lock on to the stove give the quickest service on account of the close contact. For highest efficiency those water-heaters are the best in which the heating coils are embedded in the bottom. The efficiency of a heater of one quart capacity is about eighty-seven per cent.

The advantages of electric cooking from the standpoint of sanitation and saving of labour consist in the fact that there is no smoke, flame, nor soot, and, of course, no ashes or dust arising therefrom. When in use there is nothing to indicate the presence of heat, for the apparatus has the same appearance as when cold. While the cooking goes on there is little or no appreciable rise of temperature of the air surrounding the utensils. There is no vitiation of the atmosphere and practically no radiation of heat into the room, which would be of great advantage in the summer. The apparatus may be readily accommodated on a table, thus doing away with the bulky range and its fuel. There is no labour in maintaining uniform heat; no danger of fire or explosion; no danger of personal injury or electric shock. Electricity is quite readily obtained for heating and cooking, and may be used, as has been shown, at a reasonably high efficiency. The articles are of superior quality. The work of the oven, for example, is as nearly perfect as possible. The time required, from the turning on of the current to complete the baking of a given article, for instance, may be determined to a certainty. Results which have been found the best by experience may be reproduced easily with the electric oven. It will not burn the top nor the bottom of the food, but heats quickly and uniformly. No particular attention is required to be given to what the oven contains, for there is no need of changing a pan containing bread or cake to get a more favourable position. Every loaf of bread or cake

* From an article, by Charlotte D. Seaver, on "The Economics of Electric Cooking" in the Clarkson Bulletin, published by the Clarkson Memorial School of Technology, Potsdam, N.Y., U.S.A.

COMPARATIVE COST OF COOKING WITH VARIOUS FUELS.

Source of Heat for Cooking.	Electricity.	Coal.	Gas.	Gasolene.	Kerosene.
Amount of energy or fuel required for given cooking operation	1032kw.-h.	10.5lb.	20 cu. ft.	0.0832 gal.	0.078 gal.
Cost consumed	2d. ($0.04) per kw.-h.	29s. 2d. ($7.00) per ton.	4s. 2d. ($1.00) per 1000 cu. ft.	7½d. ($0.15) per gal.	7d. ($0.14) per gal.
Cost of cooking by given source	2.1d. ($0.043)	1.8d. ($0.0367)	1d. ($0.02)	0.6d. ($0.0124)	0.9d. ($0.019)

may be obtained uniform in height, while all are of that delicious brown so highly desired.

The time required for cooking various articles of food is practically the same as by other methods of heating. It takes the same length of time to boil a potato of given size in one way as in another, to soften the fibre of meat, or to convert dough into perfectly baked bread. The gain in time in electric cooking comes from the heat being so quickly available. For light housekeeping such as is the custom in small city apartments, and in larger houses during the summer months, no other method presents so many desirable features. Gas, gasolene, and kerosene, are of course extensively used, but with the disadvantages of greater heat in the room, unpleasant odours, vitiation of air, comparative uncleanliness, and always with some danger.

Notwithstanding all its advantages, both sanitary and labour-saving, the expensive utensils and the high price charged per kilowatt-hour for the service will nevertheless tend to make the general use of electric cooking of slow growth. We firmly believe, however, that it will win its way into public favour. Electricity in the near future will no doubt be so generated as to be brought within the means of almost all of the smaller home circles. The greater comfort and convenience, on the other hand, appeal strongly to the woman doing her own work, either from choice or necessity. Indeed, it is not too much to expect that electric heating and cooking may offer at least a partial and perhaps a complete solution of the domestic-service problem, and thus meet one of the highest functions of modern science in preserving the home from the disintegrating influence so imminent whenever some help cannot be obtained for the most ordinary purposes.

A Large Electrical Heating Plant.

C. E. WADDELL.

SEPARATE and apart from the plant that heats Biltmore House, on the Vanderbilt estate, near Ashville, N.C., there was, prior to the installation of the electric heating apparatus, a plant which furnished high-pressure steam for operating the laundry and the refrigerating machinery, and in addition thereto a hot-water heater which maintained a constant supply of boiling water throughout the premises. The fuel used was anthracite coal, which cost 45s. 10d. ($11) per ton at the boilers. The plants, of course, required the constant services of an attendant. With the item of labour duly apportioned the net cost per annum for this service approximated £420 ($2000).

Electric power is purchased from a hydro-electric plant, and prior to the installation of the electric heating plant electricity was contracted for on a semi-retail basis, the price being 1¼d. (2.5 cents) a kw.-hour, the load factor and the peak determining the price. By increasing the minimum contract quantity and by maintaining a fairly even load line, energy was to be had for 0.85 cent per kw.-hour, an easy condition with which to comply, since Biltmore House contains a large storage battery. With these facts in hand it was concluded that the substitution of electric heat might effect an economy.

The refrigerating plant was disposed of by replacing the steam pump and steam compressor with a direct-current motor-driven apparatus. Direct current was selected as the apparatus is more noiseless, and, with the proper type of motor, variable speed may be secured.

Exhaustive tests led to the conviction that to supply an adequate supply of hot water it was necessary to raise 3000 gallons to the

boiling point each day of twenty-four hours; to accomplish this an electric heater similar in appearance to a horizontal tubular boiler was installed beside the anthracite heater. The heating elements are twenty in number, are arranged in concentric circles, are of a capacity of 5kw. each, and operate at a potential of 230 volts. The controlling switchboard stands immediately in front of the heater, and contains three banks of switches, each switch being connected with an element, and the three rows connected in star to three transformers on the three-phase circuit. The segregated arrangement is particularly desirable in balancing the load on the main sub-station. It was estimated that it would require 21,600kw.-hours per month to do the work; the records indicate that the average for the past eleven months has been 12 per cent. less than anticipated. The operation is the acme of simplicity. Normally 30kw. are required, two switches on each bank are kept closed, and the elements are worked in rotation from day to day. Unless something out of the ordinary occurs, the plant requires no attention whatever. In passing it may be remarked that the power factor of the heating load is unity and the load resembles in many particulars that of the ordinary lighting service.

The laundry presented a far more complex problem than did the hot-water heating. The apparatus in this consists of a mangle, stoves to heat the irons, tub boilers, and dry room equipment. The mangle was a comparativety simple proposition, as it was only necessary to equip the steam cylinder with heating elements and to provide the conventional form of collector rings, taps being brought out for several degrees of heat.

The variety of sizes and shapes of irons led to the adoption of an electric stove rather than the installation of the electric iron. In the electric stove a more rugged form of apparatus could be secured, the item of first cost was materially less, and in case of failure of current supply, resort could be made to the old stove, or in case of an extraordinary rush, both forms of heat could be called into requsition.

By far the most interesting specimens in the whole plant are the tub boilers. An article was demanded that would be economical, quick in operation, safe, and above all "fool-proof"—qualifications that are sweeping and conclusive. Of a number of suggested methods the one adopted consists in introducing hot water into a form of vertical boiler in which the temperature is raised above the boiling point, and from which steam passes into the former steam vents in the tubs. The outlet vents are not throttled, and with the admission pipe once adjusted the manipulation consists in merely turning on the hot water and closing the switch. It was at first thought that it would be desirable to provide some interlocking system that would insure the water being turned on previous to closure of the switch results have not, however, indicated the necessity of the complication, simplicity appearing to outweigh all other considerations.

Formerly the dry room was heated by means of steam coils, and as the room was provided with no means of ventilation, the temperature was above 100deg. C.—how much above cannot be stated, as the thermometer with which the observation was made had not sufficient range to register higher. To maintain any such temperature with electric heat was out of the question, and the solution of the difficulty was the most gratifying incident connected with the installation. To provide a relatively small quantity of heat and relatively large circulation of air was obviously the thing to do, and a ventilating fan was at first contemplated. The cost of operating this, however, coupled with the probability of noise, led to its exclusion, for a prime requisite in all apparatus on the premises is absolutely noiseless operation. Nearby the dry room a large chimney rises which extends through the main part of the house and above the roof, and it was concluded to pipe the dry room into a flue in this chimney, providing the flue with a damper, and ascertain the result. The artifice proved the solution; a draught was created that answered all purposes. In service it has been found that a very small opening of the damper sufficed. The relatively dry air of the surrounding rooms is sucked into the dry room, where it becomes laden with moisture and passes off.

In conclusion it may be stated that for the year 1905-06 the cost of electric service plus the cost of steam service in this particular branch of the department was approximately £850 ($4100). The cost for the identical service as performed by electricity alone in the year 1906-07 was approximately £105 ($500) less.—*Elec. World.*

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

The Edison Battery.

THE daily press has again been concerned as to the latest magical discovery of Mr. Edison. The long-promised battery—which is to revolutionise the motor-car industry, consign all petrol vehicles to the scrap-heap, create a boom in aeroplanes and flying machines, and relegate the horse to the limited active sphere of a zoological exhibit or domestic ornament, and so on—is about to be presented to the world at large. To the general public these announcements, exaggerated though they may be, are good reading, and as such sufficient; the engineer desires facts and details.

A recent issue of the *Electrical World* contained some extracts from the many patents recently taken out by Mr. Edison in connection with his development of the new storage battery. The series of patents reveals a remarkable perfection of detail in experimental work, and affords testimony as to the sustained ingenuity of the inventor. One of the patents covers a method of making seamless steel battery boxes or cans. The manufacture of these seamless steel vessels is effected by means of electrolytic deposition in a number of steps each of which is important and essential to the success of the process. Hollow brass or copper moulds of the proper form are first coated with an exceedingly thin layer of paraffin wax, over which a coating of graphite is applied. The layer of wax is so thin that the graphite apparently makes contact through the wax with the mould. A coating of copper of about 0.004in. thickness is then applied electrolytically. The mould is then removed, washed, and introduced into a second tank, where it receives an electrolytic coating of nickel about 0.001in. thick. Then it passes into a third tank containing a neutral ferrous ammonium sulphate solution with iron anodes. Here it receives an iron coating of about 0.02in. thickness. In order to prevent the formation of pits or holes in the deposited iron coating, which would be likely to form by the accumulation of gas bubbles thereon, and in order to secure a very smooth surface, a quantity of crushed charcoal is introduced into the solution, whereby the added material will rub over and scour the surface of the deposited metal, polish the same and wipe off any gas bubbles which may tend to accumulate. During the iron plating the mould is rapidly revolved at a speed of about 1½r.p.s. The mould is then removed from the tank and washed in water of a temperature of about 75deg. C., thereby melting the wax originally deposited on the mould. The deposited can is then removed from the mould and is annealed by heating it to a red heat in a closed retort containing a non-oxidising atmosphere, such as hydrogen gas. After annealing, the articles are allowed to cool in the same atmosphere. Finally, the copper originally deposited on the graphite is removed by filling the can with a solution of copper nitrate and sodium nitrate and using the can as an anode against a copper cathode.

It is quite evident that in this long process, which is, of course, carried out by automatic machinery, not a single step is superfluous. The wax coating on the mould is applied to permit later an easy removal of the deposited can from the mould. The graphite coat serves for making the surface conductive. The copper coat is necessary because a nickel deposit would not stick to the graphite. The nickel is necessary on account of the caustic soda electrolyte of the

battery. In depositing the iron, the use of the small particles of crushed charcoal not only serves for wiping off the gas bubbles, but also for incorporating a small percentage of carbon with the iron. In the subsequent annealing process the iron gets the necessary strength and, on account of the small percentage of carbon incorporated with it, it is, in fact, converted into a superior product of soft steel containing almost 0.4 per cent. of carbon.

It was early recognised by Mr. Edison that in order to get high conductivity of the active mass in the little pockets of his storage battery plates, it was necessary to mix the active mass of nickel hydroxide with some material of good conductivity. Flake graphite was first used, but in the course of a long time it was found that the flake graphite undergoes a change in its contact resistance and the capacity of the battery is thereby diminished. Mr. Edison now uses flakes of a nickel-cobalt alloy, containing say 60 per cent. of cobalt and 40 per cent. of nickel.

Of the numerous patents for the production of these flakes or films it will be sufficient to describe the method revealed in the last patent. A copper cylinder with a polished nickel-plated surface is first immersed in a suitable cobalt plating bath, and while the cathode is revolved a thin film of cobalt 0.0001in. or less in thickness is plated on the cathode. This is then washed and placed in a solution of copper sulphate containing some free acid, whereby the cobalt is caused to go into solution and the copper is deposited as cement copper in granular, but slightly adhesive form. The cylinder is then placed in a copper plating bath and an electro-deposit of copper 0.003in. to 0.0035in. thick is obtained on the cement copper, while the cathode is rotated. It is then washed and introduced into a bath consisting of a mixture of chloride of cobalt and chloride of nickel, and a cobalt-nickel alloy deposit is obtained about 0.0002in. thick. The cylinder is again washed, and a second film of copper is deposited, then another film of cobalt-nickel, and so on, producing electrolytically alternating layers of copper and cobalt-nickel, until a composite sheet of sufficient thickness has been obtained. This sheet is cut longitudinally off the cathode into small strips which are placed in a basket and introduced into an ammoniacal solution of copper sulphate and moved up and down in this bath. The copper is thereby dissolved, while the nickel and cobalt are not attacked, so that the desired films or flakes of cobalt-nickel are obtained.

The Production of Phosphorus by Electric Furnace.*

THE old method of making phosphorus that has been in use since the beginning of the nineteenth century is as follows: Bones are roasted and crushed, and the powdered bone ash (calcium phosphate) is treated with sufficient sulphuric acid to convert all or part of the calcium into calcium sulphate and the phosphorus into calcium metaphosphate, or even into phosphoric acid. This is partially evaporated, mixed with powdered charcoal, and reduced in a furnace in a clay retort. Phosphorus vapour and carbon monoxide distil off, and the phosphorus is condensed under water in a yellow waxy form.

Theoretically, the reaction would be:

$$2Ca_3(PO_4)_2 + 6H_2SO_4 + 12C = 6CaSO_4 + 12CO + 2H_2 + P_4 + 4H_2O.$$

It is found in practice, however, that the following equation represents more nearly what takes place:

$$3Ca_3(PO_4)_2 + 6H_2SO_4 + 10C = 6CaSO_4 + Ca_3(PO_4)_2 + 10CO + 6H_2O + P_4.$$

In this process much loss is occasioned by the destruction of the retorts by the acid and the intense heat, and only about one-half of the phosphorus in the charge is recovered. There is also danger of igniting the phosphorus when removing it, and great delicacy is required to prevent the vapour from condensing in the tubes and clogging them. Many improvements and modifications of this process have been patented in recent years. Woehler early suggested that calcium phosphate, either burnt bones or rock phosphate, be heated with sand and carbon without the sulphuric acid treatment, and the Wing patent, 1891, followed the same general method.

Wing Process.—In the Wing process the

* [From a publication by the United States Geological Survey, "The Production of Phosphate Rock and Phosphorus in 1906"; abstracted in *Elec. Chem. and Met. Ind.*]

charge of bone ash, or pulverized rock phosphate, and silica is moistened and made into balls and is placed in layers in the cupola with coal between, which furnishes incandescent carbon to reduce the phosphoric acid fumes. The silica releases the phosphoric acid from the phosphate in the form of anhydride P_2O_5, which is reduced by the incandescent carbon and a reducing flame to phosphorus. The fumes pass off to depositing chambers kept at a temperature of 500deg. F., where most of the phosphorus is deposited in the red form and the remainder is caught in a water chamber as yellow phosphorus. The process is made continuous by feeding the charge from the top, dumping the residuum from the grate below, and using two depositing chambers alternately. With only the ordinary furnace at command this method was found impracticable on account of the high degree of heat required to smelt so refractory a charge. Electricity as a powerful heating agent had been known for some time and was looked to as the solution of the problem, but the invention of the electric furnace has only recently made it commercially feasible. It has now been generally introduced throughout Europe and America in the production of phosphorus on a profitable basis.

Readman Patent.—This is the process which, since its introduction in 1889, has come into commercial use in most countries. Bone ash or crude phosphoric acid is mixed with powdered coal or charcoal, or, if mineral calcium phosphate is used, it is roasted, crushed and mixed with charcoal and silica or some basic salt. The mixture is reduced in a continuously operated electric furnace in a reducing atmosphere, by passing the current from carbon electrodes through the mass which acts as a resistant conductor and is heated to incandescence. The silica combines with the calcium to form calcium silicate slag. The phosphorus and carbon monoxide distil off as before. Distillation begins at 1150deg. C., and requires 1400deg. to 1500deg. C. to complete the process. The chemical reaction is

$$2Ca_3(PO_4)_2 + 6SiO_2 + 10C = 6CaSiO_3 + 10CO + P_4.$$

Harding Process.—In Harding's patent, 1898, pulverized rock phosphate is boiled with sulphuric acid, and the phosphoric acid, free from lime, is filtered out and boiled down to a syrup. This is mixed with granulated carbon, heated in a reverberatory furnace, and then smelted in an electric furnace by electric arcs between the electrodes and the mass. A hydrogen atmosphere is obtained by spraying gasolene into the furnace.

Gibbs Furnace.—In this furnace, which was devised especially for phosphorus manufacture, the electricity instead of discharging through the mass passes through a continuous high resistance medium, such as a carbon rod, placed above the charge. The rod becomes incandescent, and the roof, which is arched over the grate, reflects the heat as in a reverberatory furnace.

Irvine Furnace.—The Readman process was modified by the Irvine patent in 1901. The charge is the same as in the earlier method, although either aluminium or calcium phosphate can be used with the silica or basic salt flux. The two carbon electrodes are suspended vertically from above, and are connected below at the start by coal, through which the current passes. After the charge melts the slag forms on top, and thereafter the current passes through it as the conductor between the electrodes. Fusion is continuous, and the excess of slag is tapped off gradually so as not to expose the ends of the electrodes.

Duncan Patent.—A process patented in 1903 by Duncan takes 77 parts of powdered phosphate, either organic or mineral, and 23 parts of powdered carbon, mixed with tar as a binder. This is dried, and after a preliminary heating as a matter of economy in a hydrogen flame, a by-product in the manufacture, it is placed in an electric furnace and calcium phosphide continuously produced. This is put into a chamber submerged in hydrogen; after adding water it forms phosphorus hydrides. Upon heating the hydrides are reduced to phosphorus in pure state, either red or yellow, depending upon the degree of heat at which it is allowed to deposit.

Parker Patent.—In 1902 Parker patented a process in England for the reduction of aluminium phosphate. It is treated with sulphuric acid and then with an alum-forming sulphate, all the alumina being removed by the crystallization of the alum previous to the electric treatment. The residual liquor is mixed with coal and other carbonaceous material and reduced in an electric furnace.

Landis Method.—The American Phosphorus Company, of Philadelphia, have a

plant at Yorkhaven, Pa., where they extract phosphorus from wavellite by a method invented by Mr. G. C. Landis, chemist of the company. The process, which is kept a secret, is, so far as could be learned, similar to the Readman method, except for the ore and the furnace. Wavellite, aluminium phosphate and calcium phosphate, obtained from South Carolina, are roasted, mixed with silica and charcoal, and reduced in the patent electric furnace. In January, 1907, a patent was secured on certain improvements in the furnace designed to prevent the escape of fumes, vapours and gases, or their absorption by the furnace lining. This is accomplished by an outer lining of non-absorbent brick and by a sealing device for all openings into the furnace whereby the projecting flanges of the joints are enclosed in a moat of water. The furnace has an inner lining of carbon bricks which acts as one electrode, and one or more vertical carbon electrodes are used which may be adjusted either to furnish a continuous current through the charge or to produce with it an electric arc. The slag is drawn off every three or four hours and the phosphorus fumes condensed under water. Probably some additional treatment is required to remove the alumina in the batch similar to the Parker patent, and this is what is kept secret.

The phosphorus obtained by most commercial processes is a crude form of white or yellowish waxy variety, and contains sand, carbon, clay and other impurities. These are removed in various ways—by filtering while molten through powdered charcoal or canvas submerged in water, by forcing the molten mass through porous pottery by means of steam, and by redistillation in iron retorts. The best method of purification, however, is to treat the crude phosphorus, when molten, with a mixture of potassium dichromate and sulphuric acid, or sodium hypobromite, some of the impurities being dissolved, others rising to the surface as scum.

Because ordinary white phosphorus is very poisonous and injurious to handle, other forms of the element have been sought. Red amorphous phosphorus, which is not poisonous, is readily prepared by heating the ordinary variety to 250deg. C. in a closed vessel under pressure or excluded from air and water. It has not the same qualities, however, as the white crystalline variety. A red crystalline form, recently discovered in Germany, is made by heating to boiling a 10 per cent. solution of white phosphorus in phosphorus tribromide. This is not poisonous and is an efficient substitute for white phosphorus in making matches.

The world's production of phosphorus has been variously estimated to be from 1000 to 3000 tons a year. The greater part of the world's supply is made in the Albright & Wilson factory, Wednesfield (Oldbury), England, where the Readman process originated. The output is said to be 500 tons a year. Other large factories are located at Lyon, France, and at Griesheim and Frankfort, Germany. There is also a plant in Sweden, and numerous smaller ones in Russia, six of which, located near Perm, had an output of about 140 tons in 1890.

In the United States the first phosphorus works were built about forty years ago in Philadelphia by Mr. Moro Phillips, and this factory has continued in operation until very recently. The J. J. Allen's Son's plant was established in Philadelphia in 1891, and it supplied the Diamond Match Company, the largest match factory in the United States, in competition with imported phosphorus. In 1897 the English firm of Albright & Wilson, under the firm name of the Oldbury Electro-Chemical Company, built a 300h.p. factory of the Readman type at Niagara Falls, which thereafter supplied the Diamond Match Company and the greater part of the domestic product. This firm has recently made a further improvement in its plant by introducing the Irvine patent furnace, by which method 80 or 90 per cent. of the phosphorus is reported to be extracted from the raw material, a high-grade phosphate rock. This is similar to the results obtained in the English works, where 86 per cent. is recovered. They have six furnaces of 50h.p. each with a capacity of 170lb. of phosphorus a day, a total of 1000lb. a day. Their production varies according to the demand, but they furnish at present over 50 per cent. of the domestic product.

The American Phosphorus Company put a new mill in operation in 1905. Electric furnaces were installed, but the production of electricity by steam was expensive, and in 1906 the mill was moved to Yorkhaven, Pa., where electricity generated by water power could be had. This company reports a production of about 500lb. a day and a capacity of about 1200lb.

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Photographs by Wire.

[The following general description of the Korn system of electrically transmitting photographs will be read with interest. It is abstracted from an article by T. Thorne Baker which appeared recently in the *Daily Mirror.* In another part of this number is reproduced a portrait of H.M. the King, which was the first electrical photograph sent into this country by telegraph wire and submarine cable.]

It is possible, by means of Professor Korn's invention, to insert a photograph in one machine in a certain place, and to receive, within twelve minutes, an exact facsimile of it in another machine placed a thousand or more miles away.

A photograph on a film of celluloid is attached to a glass drum, which revolves in a spiral fashion, so that as it turns it automatically rises in height. All light is shut off from this drum by means of an outer box, except for a very small hole in the front, on which a powerful light is concentrated by means of a special lens. It will thus be seen that the light, by falling on the hole behind which the film is rotating, will meet with consecutive tiny portions of the photograph, one after another, which are, of course, of different intensities.

Inside the revolving cylinder is a prism—a mirror, in effect—which reflects all light which penetrates the film (*via* the hole in the box) on to a selenium cell placed at one end of the box. Hence, as the photograph rotates, and the portions of it which intercept the light and the mirror vary in intensity, so the amount of light which is reflected from the mirror inside the drum on to the cell varies correspondingly.

Now, the circuit or transmission line between the sending and the receiving instrument passes through this selenium cell, which offers considerable resistance to the electric current. But this resistance varies as the cell is illuminated; when a transparent portion of the film enables the mirror to reflect much light on the cell, the current passing through the latter is strong, and when a dark portion of the photograph causes only a little light to be reflected on to the cell, the electric current is weaker, and so on.

At the receiving station, therefore, one receives a number of rapid, successive changes of electric current—that is all. But by means of Professor Korn's exceedingly clever receiver these current changes are utilised to form a photographic image precisely like that transmitted. A lamp is placed at one end of the receiving machine, and at the other is fixed a light-tight box containing an unexposed photographic film attached to a cylindrical drum, which is revolved, again with a spiral motion, by a motor at almost exactly the same rate as that of the transmitting drum. The light from the lamp is concentrated by a lens upon a tiny hole in the box, so that a spot of light falls on the sensitive film as different consecutive portions of it come just behind the hole.

Between this little aperture and the lamp is placed a powerful electro-magnet, and between the poles of this magnet are two fine silver wires, to which is attached a tiny piece of aluminium foil in such a position that it just throws a deep shadow over the hole in the box containing the receiving film, and thus protects it from the light.

Now, the constantly changing current which emanates from the transmitting machine is passed through these fine silver wires, and they are deflected more or less, according to the intensity of the electric current which is passing through them. As the foil is carried to one side by the fine wires to which it is attached, it is obvious that the shadow it forms on the box will be more or less shifted from the little hole, and consequently the light from the lamp will penetrate the hole and act on the sensitive film behind it whenever the shadow is shifted. The shadow, of course, is shifted to a degree depending on the strength of the electric current which is being received from the transmitting station, and, as the shadow moves, so the film is exposed.

When, therefore, the receptive film is developed—just like an ordinary photograph—we get a series of consecutive dots varying in intensity precisely according to the transparency of the corresponding tiny portions of the original photograph. A negative is obtained at the receiving station from a positive, and *vice versa.*

Various elaborations of the instrument were necessary to overcome faults which were at first inevitable. The chief of these is an extra selenium cell in the transmitter whose properties are the reciprocals of the chief cell, and these reciprocal "faults" neutralise one another, so that the change in electrical resistance with change in the light is made much more instantaneous and abrupt.

Special arrangements were also made to ensure the transmitting and receiving drums rotating at a uniform rate. As a matter of fact, by a form of electrical relay, at the end of each revolution of the receiving cylinder the latter is automatically stopped—just for an instant. It rotates slightly more quickly than the transmitter, and the moment the latter has completed its revolution the receiving drum is released again by the relay, and the two once more rotate in unison, *i.e.*, synchronously. This contrivance prevents any faulty working from causing a defect for more than one revolution.

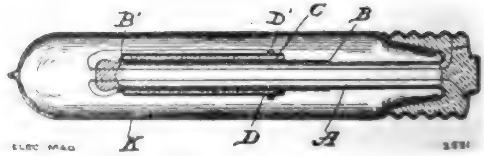
The spiral line of light, always altering in intensity, according to the light and shade in the photograph, causes the pictures to appear furrowed, and they are indeed composed of a number of parallel lines varying in thickness and depth of tone.

A New Selenium Cell.

An interesting patent for a new type of selenium cell has recently been taken out by W. J. Hammer, of New York. In this cell the inventor has introduced several novel features, each of which has a specific purpose. The cell is, of course, designed for use in an electric circuit, a portion of which is to be made sensitive to changes in illumination, and the object of the invention was to provide a cell permanent in its characteristics and mechanically strong, so that it could be handled easily, and readily inserted or withdrawn from the circuit. The cells heretofore constructed have been delicate, and required most careful handling, and often were not sufficiently protected from outside influences. In order to overcome the last trouble, such cells have frequently been enclosed in glass vessels, the object being to transmit light to the cell, at the same time to protect it from moisture and other atmospheric influences. Glass, however, is practically opaque to the higher radiations, and hence, used in this way, screens the cell from such radiations, although they may be present in fairly large proportion, and should be allowed to fall upon the cell in order to produce a corresponding effect.

The form of cell devised by Mr. Hammer is shown in the accompanying figure. This, of course, may be varied, although the essential features are not changed. In this figure there is a central tube, A, of fused quartz, this material being employed because it may be heated to a high temperature and cooled rapidly without breaking, and in doing this its low coefficient of expansion does not injure the layer of selenium placed around it. This tube is coated with metal foil, B, usually thin so as to avoid strains upon the selenium due to expansion and contraction during the forming process. In some types, if desirable, this inner layer of metal may be made thicker and constitute the supporting element.

Upon this metal foil, the selenium, C, in



The Hammer Selenium Cell.

pasty form, is spread out uniformly in any convenient way, which may be by rolling the tube thus coated between glass plates, thus securing a smooth, compact, and highly polished layer. Over this layer of selenium, a very thin metal foil, D, is placed. The material may be gold, silver, or, better still, aluminium. This film should be so thin that it is transparent to light, and for this aluminium is particularly useful because of its white colour and the tenuity of the films which may be formed. The element, if thus constructed, consists then of two films of metal separated by a layer of selenium and carried on some support. In practice it is desirable to use metal films with thickened ends, as shown at B′ and D′ in the figure, so that good electrical connection may be made to them.

The element thus constructed is then heated to the necessary temperature in any way, such, for example, as holding it over a Bunsen flame and letting the latter pass up through the quartz tube. After the necessary temperature has been reached, the element is removed from the flame and allowed to cool. It is then placed within a bulb, K, sealed in after suitable connecting wires have been brought out and the bulb is exhausted. This removes any moisture which might be in the tube, and any gases occluded in the element. The best form of tube is one of quartz glass, since this is transparent to the short wave-lengths of light, but a cheaper form may consist of a glass bulb into which a quartz window has been fused.

With this form of element there is a continuous layer of selenium in the sensitive condition between the two sheets of metal, which, the inventor claims, is much better than imbedding two parallel wires in a layer of selenium. Frequently in cells of the latter type, the selenium is supported on metal which acts as a shunt to it and thus reduces its sensitiveness. With a cell constructed in this way a smaller amount of selenium may be used and still give a cell more sensitive than the older types, and since the entire current passes through the light sensitive substance, there being no shunting support, the sensitiveness and accuracy of the cell are increased.

The protection of the cell as described renders it independent of outside influences, and thus makes it a permanent device.

It is interesting to note in this connection the inventor's contention that there is no such thing as "photo-electric action" of the selenium cell. That is, if one puts a cell in circuit with a galvanometer, and allows a light to fall upon it, no deflection is obtained, as has been asserted; in other words, there is no electromotive force set up. The effect of the light is merely to change the resistance of the selenium layer so as to allow a larger current, supplied from some other source, to flow through the circuit.

There is one advantage of this type of cell worth mention: that is, by the use of gold, silver, or aluminium for the metal foils, no chemical action takes place, since these metals do not react with the selenium as do copper and certain other elements, and this, of course, destroys the permanency of the cell.—*Elec. Rev., N. Y.*

The Belin System for the Electrical Transmission of Photographs.

[The Paris correspondent of the *British Journal of Photography* has an account of M. Edouard Belin's method of transmitting photographic images electrically, in that journal of the 22nd inst. The following is an abstract of the article.]

THE French scientist, M. Edouard Belin, of Nancy, has been engaged with the question of the electrical transmission of photographs, and the interview and demonstration which he afforded at the Société Française de la Photographie, Paris, inspire confidence that a very considerable advance has been made. M. Belin has made himself expert in sensitometric problems, and it is these studies which have led him, he claims, to the solution of some of the most important problems in technical photography: transmission of a given photograph by wire, a self-registering opacity meter, a registering sensitometer, and last, not least, the transmission by wire of the image of any given person, object, or proof. The last problem, not to be confounded with the first, is the one M. Belin has been longest devoted to, but, having put it aside for the others, its solution is not complete. None the less, he is confident of success, and that fairly soon.

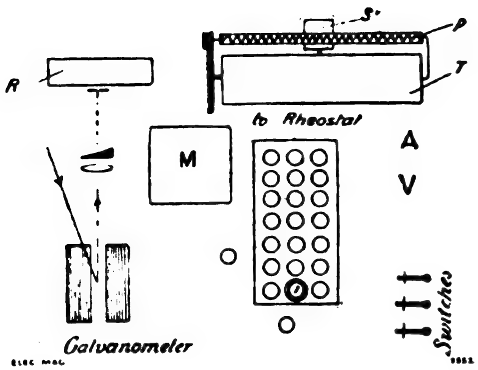


FIG. 1.

The first question M. Belin claims to have completely solved in a manner fulfilling certain stringent conditions. These are:

1. That the image received should be of precisely the same dimensions as that transmitted.

2. That they should be reproduced, or reduced, or enlarged if desired, but the detail should remain on the same scale as if the original size were preserved.

3. That whatever the original, a positive or negative image can be formed at will at the receiver. The value of this for photo-mechanical processes is obvious. The nature of the original is simply telephoned to the receiving station, when adjustment is made accordingly.

4. Further, the image received shall be of the same intensity as the original, or, if desired, can be intensified or reduced. And this is obtained by no subsequent chemical treatment, but during transmission by a simple physical adjustment.

It now remains to describe the apparatus which performs these marvels. The complete model installation, containing transmitter, receiver, motor, and a resistance line of 4000 ohms, equivalent to several hundred kilometers, is mounted on a stand about a metre square.

The method adopted is entirely different from that of the Korn system, which utilises the varying electrical resistance of selenium when exposed to light. Belin calls his procedure "Telestereography," or transmission of a relief to a distance, and one essential lies in the use of a carbon print as the original transmitted, such a print being, of course, a relief in which the contours are proportional to the intensities of the image.

This print is wound on the cylinder of the transmitter T. In perfect synchronism with this revolves the cylinder of the receiver R, the synchronism being effected by the use of an alternating current. As the cylinder of T revolves a small point or style in contact with it moves along the axis P, which is geared on to the cylinder or drum. The conditions chosen are such that the print advances lineally 1 mm. for six turns of the cylinder, from which results that detail down to $\frac{1}{6}$ mm. is faithfully reproduced. The movements of the point or style are transmitted by an arm to a small sliding contact or roulette, working on a minute rheostat. This rheostat consists of twenty very small plates of copper separated by layers of mica and each branching off to a resistance coil.* There are thus twenty variations of the intensity of the current possible. At the commencement, before the alteration introduced by the cylinder, there is simply a large resistance *o* of 4000 ohms, the movement of the transmitting cylinder and the style then call into play the variations, always according to the contours of the carbon image, and hence in proportion to the values of light and shade.

The variations in the current of the circuit, proportional as they are to the intensities of the image, are registered by the delicate reflecting galvanometer of Blondel, known as the oscillograph. This instrument will respond to variations of current at a frequency of 50,000 per second.

The diagram (2) explains the disposition which enables the registration as a photograph to be effected of these electric fluctuations. An aplanatic lens *l* throws an image of the reflected ray from the mirror on to a small hole f_2, this hole being $\frac{1}{6}$ mm. in diameter: f_1 and f_2 are conjugate foci of the lens. Behind this minute hole revolves the second synchronised receiving cylinder R, on which is a photo-sensitive surface. The

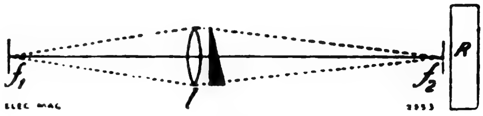


FIG. 2.

* M. Belin explained that he had chosen a range of 1-20 as representing the possible range of contrast in photo-mechanical processes.

hole is so near the film as practically to be in contact with it so that any diffusion of light is avoided. In other words an image of the hole is continously printed on the film, and this means that detail is preserved to $\frac{1}{6}$mm. Under these conditions, there would still be no variation of the light intensity. The way this is effected—that is, the method by which the deviations of the galvanometer are converted into light intensities—is ingenious. Behind the lens (see Fig. 2) is a scale of tones, *i.e.* of densities (in the sense of Hurter and Driffield), increasing from bare glass to a certain value; in fact, an optical wedge. Various ways of producing this optical wedge may be employed: at present M. Belin uses a photographic plate specially exposed. The scale of densities increases in proportion to the mirror deviations, *i.e.*, to the intensities of the current, and the more (or less) it is absorbed, so that the hole is illuminated by light varying in intensity with the intensities of the original image. The density scale is mounted on a revolving axis, so that according to the direction of increase of density, relative to the mirror deviations, a positive or negative image can be obtained at will on the receiving film, fulfilling the third condition mentioned at the start.

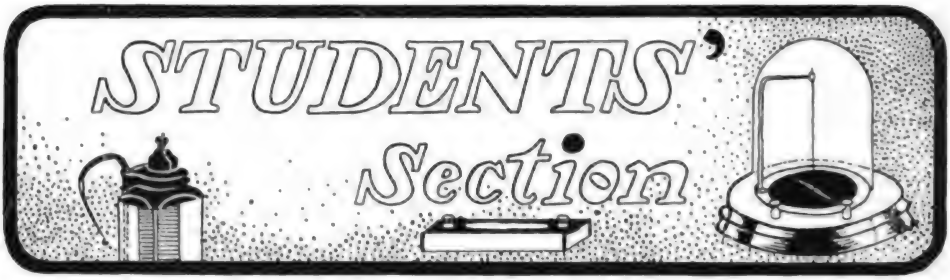
Again, if instead of a scale of tones corresponding to those of the original, one of harder or softer gradation be substituted, the image may be obtained reduced or strengthened in intensity and by purely physical means.

It must be confessed that both the ingenuity and the comparative simplicity of the apparatus make it very promising. The results obtainable at present are very fair, and M. Belin hopes by certain slight modifications, such as a refinement of the rheostat and the cursive point, to greatly improve the rendering. In two or three weeks, with the promised aid of the State telegraph lines, he hopes to give a public demonstration of its capabilities over long distances, an event which will be awaited with much interest. M. Belin states that he can also transmit writing in relief by his instrument, and that the question of speed is one chiefly conditioned by the fineness and perfection of mechanical and electrical details. At present the transmission of a 9cm. by 12cm. image occupies about 30 minutes.

As to the more romantic problem of simultaneously photographing and transmitting the image of any object, scene, or person, M. Belin would only state that the idea involved was entirely different from that sketched above.

Decay of Poles.

THE Universal Pole and Post Preserving Company, of Circleville, Ohio, engages in a novel means of preserving the footings of poles from decay. The method of the company under their patented process is to remove the earth around the pole to a depth of about 16in. Then all the decayed wood is scraped or cut away with special tools and a hole is bored to the centre of the pole to discover if the centre is sound. If the centre of the pole is hollow this is filled with a chemical in solution with water. An asbestos and asphalt jacket of special manufacture is then placed around the pole, leaving a space between the jacket and pole of about one inch This space is filled with a composition of germicidal chemicals mixed with sand, and the top is sealed and a good finish is placed upon it with cement. The appliance is more indestructible than the pole, and together with the chemicals will protect the pole for a period of many years. The chemicals applied to the pole will kill the fungi and destroy the enzyme, and at the same time will harden the wood. Poles treated seven years ago show no infection at the present time. The jacket is so durable that, at the end of a given number of years, the contents can be freshened by the injection into the space between the jacket and pole occupied by the sand of a new supply of fungicide.



Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

*The Study of Men.**

J. F. HAYFORD.

If you prove to be a successful engineer you will pass through three periods with reference to the acquisition of knowledge and wisdom. First, the school and college period when you acquire through books and teachers. Second, the period comprising the first ten or more years after you leave college, the period during which you will occupy subordinate positions and be in close contact with material facts. By that close contact with facts you will gain experience which will remedy, to a considerable extent, the inevitable defects of any education furnished by books and teachers alone.

Just as rapidly and as certainly as you gain real success by showing ability to make yourself useful in the world, and by using your ability, you will find your responsibilities increased, the demands upon you increased, and you will find that you cannot, if you are to accomplish most, remain in direct contact with all the facts of your daily work.

You will enter into the third period with respect to the acquisition of knowledge and wisdom. You will find yourself in a position where you must acquire knowledge through your subordinates who are themselves in more direct contact with the facts. The chief engineer of a railroad, the chief engineer of a great government engineering bureau, the head of a great technical school, necessarily sees the facts of the work for which he is responsible mainly through the eyes and brains of his subordinates. In the third, or executive, period then, as in the first, or school period, the successful engineer acquires knowledge and wisdom by utilizing the brains of other men.

When you are in school and college you are, as a rule, learning things which were well known long before your time, you are acquiring knowledge which is well organized by the successive efforts of many men, teachers and authors.

As you gradually, by being successful, pass into the third period in which you again depend upon utilizing the brains of others, you will find that the facts you must deal with have not been known long, that they are not well organized, that they come to you through one man or through a short series of men only, and that as a rule the relations between the facts are but dimly perceived by the men from whom you get them. Under these conditions the facts and principles come to you highly coloured and greatly distorted and but dimly outlined because of the peculiarities of the man, or the few men, through whom you get them. It becomes, therefore, of prime importance to you to understand that man, or those men. To be entirely successful you must study men.

The well-known and well-organized facts and principles will be dealt with by your subordinates without coming to you for attention. An engineer does very little directly without the intervention of other men between him and his accomplishment, even when he is in minor, subordinate positions. The inspector on construction may see with his own eyes, but he produces

* Extracts from an account in *The Electric Journal* of an address delivered at the Clarkson Memorial School of Technology, Potsdam, N.Y., June, 1907.

changes only by operating through a foreman or perhaps a chain of several men, including the engineer to whom he reports, the contractor, the contractor's foreman, and finally the workman. The draughtsman may seem to be directly in contact with his work, but he really accomplishes something only as he succeeds by means of drawings in guiding the skilled workman whom perhaps he never sees. In each of even these simple cases the effectiveness of the engineer is dependent in part on his accurate understanding of the thoughts and feelings of the men through whom he works.

As an engineer rises higher in the organization with which he works, his field of influence becomes larger, but the line of men through whom he works to produce material results also lengthens. He works to an increasing degree through other men and it is of increasing importance that he understand other men.

An engineer works through other men not connected with him in any organization by convincing them of the correctness of his view, and of the advisability of doing certain things. He produces results in these cases by convincing. It may seem at first sight that in this respect a man works in a different way through other men according to whether they are his subordinates in a close organization or are outside the organization. But experience will show you that there is no real difference. You can be effective in producing results through your subordinates in an organization only by convincing them that you are right, though it may not be necessary that they understand why your decisions are right. If you do not convince, your subordinates will accomplish whatever is within their native ability to accomplish unguided, but no part of that accomplishment will be due to you.

If you are to succeed—to be valuable in the world—to know is not enough, you must make others to know. Your power of passing knowledge from your own into another man's mind depends largely upon your understanding of that man. Hence you must study him. If you understand him and have a thorough mastery of the topic in hand then your success in convincing him still depends largely on your skill in using language, in making words effective carriers of ideas. Language is one of the tools of an engineer—a tool which he has frequently neglected because he has as frequently failed to realize that men are also his tools.

As soon as you are well started in studying men you will find yourself studying the need and purpose of organization. For as soon as you fully realize what great differences there are in their principal characteristics, and even how widely the capabilities of a given man may vary at different stages of his life, you will realize why and how it is that a group of men working together as an organization may accomplish much more than the same men could if they worked independently, as individuals.

A very common conception of organization is that it is an arbitrary arrangement by which orders are transmitted by various steps, through different groups of officials, from the man at the head of the organization to the many men who form the rank and file and do the actual work. Many graduates have shown that they believe that the way for a man in a high position to get a thing done is to order it done. Poor and inefficient administrators may do it that way. The successful administrators are men who act on the principle that their business is to administer unto those below them in the organization in three ways. First, by putting them into such places and under such conditions that they can do their best; second, by giving them orders necessary to show what is expected of them; and, third, by enlisting their wills as well as their bodies and minds in the work of the organization so that they will do their best. The first and third of these the average graduate has never seriously thought of. He sees in the administrative officer the man who orders. The successful administrator finds his time so thoroughly filled with the first and third kinds of administration, with putting each man in the place and under the conditions most favourable to his effectiveness, and with enlisting in the service the will of the man, that orders fill but a small part of his horizon.

The men near the top in an organization normally do the most difficult work. Normally they are the men who work most intensely and for the longest hours.

Study men, and especially from a certain point of view—the point of view of one who wishes to attain success as an engineer. You may properly ask how it is proposed to study this subject. Study it as you should study any other engineering topic. Use the

best books you can find, study current practice as shown in current literature, study the facts and principles directly whenever you can.

You will find at the outset that no one existing book will serve as a text-book. There certainly are fundamental principles capable of being put into words which are daily being applied by successful administrators. But these administrators do not put them into words themselves. They are too busy. Some of them will tell you that they act by intuition. If the principles are put into words it will be done by some one who makes that his chief aim for the time being, some one who will study carefully the words (spoken and written) and the acts of successful administrators, and perhaps failures in that line also. You must not expect the man who is successful in dealing with men, the successful administrator, to tell you how he does it. You must directly, or through others, watch his actions and their effects, listen to his spoken words, and read his writings on all sorts of topics.

To sum up: You have in your college course been studying material things—the facts of nature and the laws of nature. You have been acquiring that engineering knowledge—knowledge of the forces of nature and the strength and properties of materials —which is absolutely essential to your success as an engineer. You have studied man comparatively little. You have acquired your engineering knowledge largely through men, and will continue to do so. The soundness of your engineering knowledge depends in part upon your knowledge of men; but, what is still more important, the effectiveness with which you will use your engineering knowledge depends very intimately upon your knowledge of men. Hence, you are urged, as you do your part in the world, to study men as well as engineering. You are urged to pay attention to all phases of the men around you, to see and appreciate them as literary and artistic men, as well as technical men; as men of feeling as well as men of thought; as incarnated motives as well as thinking and working machines.

To attain to the highest success as an engineer you should be able to reach correct conclusions quickly when you have the facts before you for direct observation; you should also have the power to draw correct conclusions quickly from information which comes to you through other men. This power comes very largely from knowing men.

To attain to the highest success as an engineer you must not be the type of man who knows how to do things excellently, but cannot tell others how to do them—the man who gets knowledge abundantly but can apply it only through his own fingers. Instead of devoting your energy simply to increasing your own output by fifty or even one hundred per cent., it is far better—you make yourself more useful to the world—that you should use your energy to increase the output of each of one hundred men by ten per cent. The world recognises this by awarding the prizes to the administrators.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

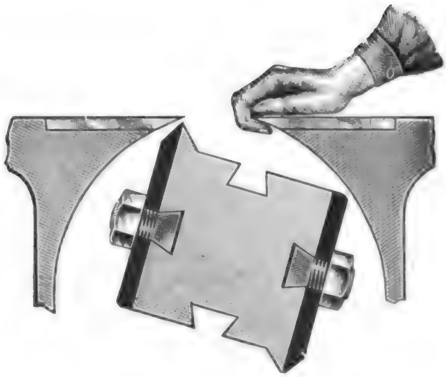
Wood-working Machinery.

M. Glover & Co., Leeds.

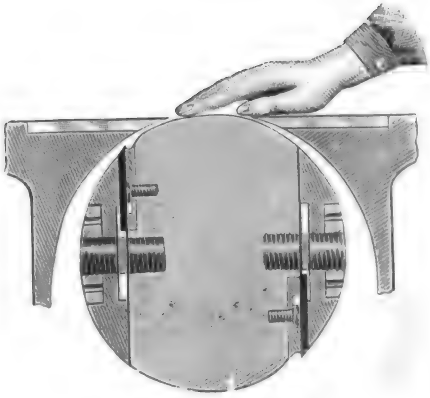
At the recent Engineering and Machinery Exhibition at Olympia, Messrs. M. Glover & Co., saw-mill engineers, had a very varied and interesting exhibit of valuable working models of their patent firewood splitting and bundling machinery, when examples of most difficult and knotty wood beautifully split into sticks and bundled were shown. The company also exhibited one of their improved high-class saw benches, and several examples of their patent "Ideal" saw guards, which have met with very great success, judging by numerous testimonials and well-known names of users exhibited, including most of the railway companies and Government departments, &c.

Special attention should be directed to a most important exhibit, calculated to absolutely prevent the possibility of such serious accidents and multilations as now are very frequently caused by the old square type of cutter block, as used in the usual form of surface wood-planing machine. The new patent circular "Safety" cutter block was shown in operation doing good work. This device is advantageous to the user in many ways, apart from the vital benefit of its being safe, which thus rids an employer of one of his heaviest risks whilst conferring a great boon upon those whose lot it is to have to work these hitherto most dangerous machines. This invention is very largely of great public interest, inasmuch as it affects large numbers of people working amongst dangerous wood-planing and circular-sawing machinery throughout the Kingdom.

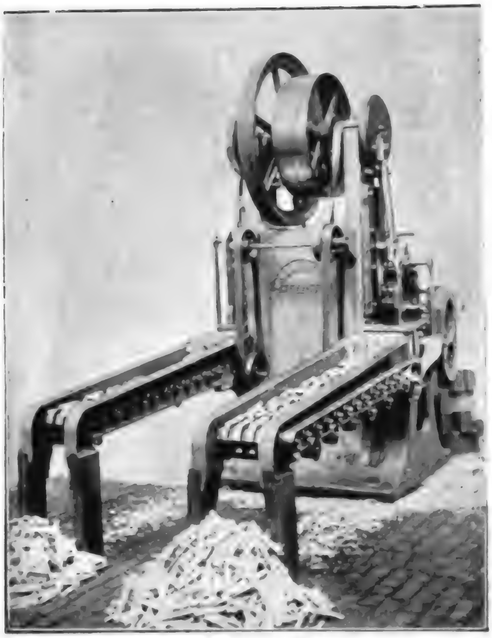
This firm's improved patent saw-sharpening machine is a very compact and efficient appliance, and shows a distinct improvement over other systems. By means of this machine the old-time method of punching



Old Style Cutter Block.



The "Safety" Cutter Block.



Firewood Splitting Machine.

and hammering is overcome; and saws last very much longer.

An additional exhibit of this firm was a perfected appliance for compressing and bundling box and case boards, thus enabling the latter to be conveyed compact and uniform to destination at considerably reduced transport rates.

Messrs. M. Glover & Co. are also the inventors of a new machine which should appeal to box and case makers as well as tinners, as it embodies several features and movements, and gives superior results in such work as bending the edges of sheet tin or zinc to any angle, or right back in order to form double joints. Double-jointed tin linings protect the contents of boxes and cases from damage during transport through handling, and are much more reliable than linings straight lapped at the joints and soldered. A valuable feature of the mechanism is the double lever, so designed that the work is done right at the centre of the lever, thereby obtaining every possible ounce of leverage and enabling the machine to be easily operated by a boy. There is also a wide press or vice which compresses the two folded parts together, making, without solder, a strong and permanent joint of two sheets in quick time, the whole process being rendered extremely simple and easy.

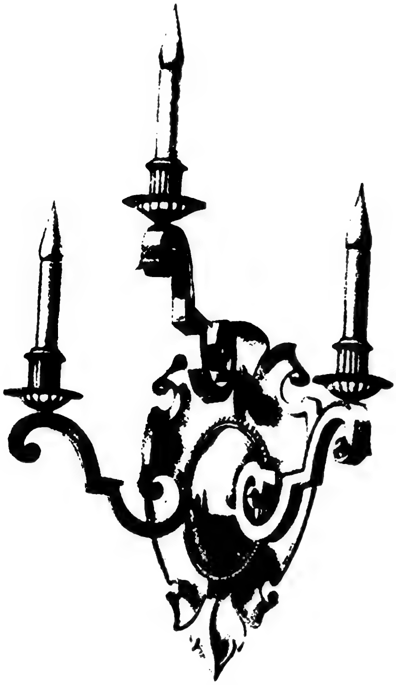
Angold Arc Lamps.

The General Electric Company, Ltd., London.

The conspicuous features of the well-known "Angold" arc lamp illustrated below are that there are no shunt coils, nor internal resistances; the length of the lamp is but 24in. and the current required is 6amp. The absence of shunt coils entirely eliminates the trouble caused by these burning out. Any lamp which will run in parallel on 100-125 volts will run equally well in series with a similar lamp on double that voltage, "parallel" and "series" lamps being the same.

Line resistances are included in each lamp, so that they are complete ready for connecting to circuit. The most useful lamp is the single-enclosure type, as illustrated, for indoor or outdoor use; but double enclosure can be supplied at the same price if required.

Angold Arc Lamp Single Enclosure Type.



Artistic Wall Fitting of "Armorite" Metal.

"Armorite."

The General Electric Company, Ltd., London.

UNDER the distinctive trade name of "Armorite," the General Electric Company are introducing a new metallic medium which can be worked up into electric, gas, or oil fittings, door furniture, gates, grilles, railing, &c. The illustration below shows a new and representative design of artistic wall-fitting made in this metal. The technical qualities of "Armorite" are a blend of roughness with rigidity, strength, and great ductility. After exhaustive and practical tests the makers claim this metal to be incorrodible, and to retain its soft silver-like lustre, even though exposed to sea-air, fog, or dampness, and it is not affected by humid foreign climates. The appearance of the metal is not unlike oxidised silver or armoured steel, having the advantage of the beautiful colour of the former, and the texture of the latter, which gives the finished article an artistic quality that is often hard to find in these days of machine-made goods.

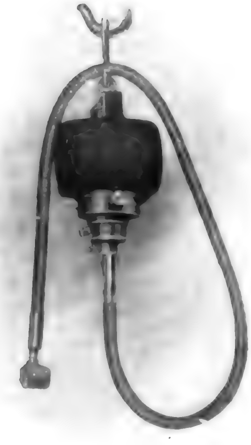
The General Electric Company, in their usual enterprising way, are losing no time in bringing "Armorite" before electrical engineers, contractors, and architects, and at their showrooms are showing a large selection of fittings, door furniture, switch-plates, staircase panels, hinges, and general interior ironwork. They are also quite prepared to make up any special lines that a customer may require. Their works are now busily engaged upon several large contracts for "Armorite" fittings made to their own special designs, among them being some large fittings for a northern cathedral, each fitting having a diameter of 9ft. and having a massive appearance. Orders are also in hand for fittings for a number of churches, public libraries, municipal offices, insurance offices, and private houses.

Another important factor is that the prices run considerably below those charged for fittings in oxidised silver, polished brass or copper, and are only slightly in excess of those charged for wrought iron.

Electric Horse-clipper.

Electromotors, Ltd., Manchester.

A SPECIALITY which this firm has put on the market is an electrically-driven horse-clipper, the principle of which is clearly shown in the illustration below. This useful device consists of a totally enclosed dust-proof motor specially designed for the purpose, and provided with an eye-bolt for hanging on to a hook. The motor



The Electric Horse Clipper.

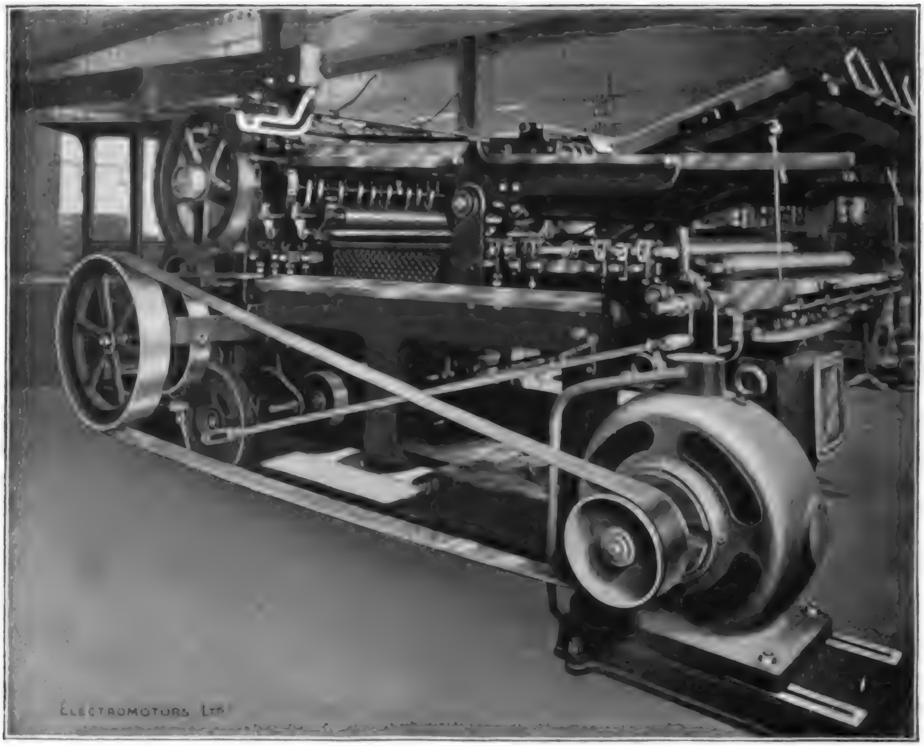


FIG. 1. ELECTRIC MOTOR DRIVING LETTERPRESS MACHINE.

is fitted with a flexible shaft enclosed in an outer cover which enables the clipper head to be easily manipulated on the work. Detachable plates are provided with the clipper head, and a complete set of separate plates can be supplied suitable for sheep-shearing. With this machine it is possible for a man to clip a horse, complete, in half an hour.

Power for Printing.

Electromotors, Ltd., Manchester.

THE illustrations herewith show two interesting views of the application of electric motors to the driving of printing machines. Fig. 1 illustrates a two-revolution letterpress machine made by Messrs. Furnival & Co., Ltd., driven by belt from a 4½h.p. motor. On this machine there is no loose pulley supplied and consequently the motor is shut off every time the printing machine is stopped. This does away with the disadvantage of the motor running on light load when the printing machine is standing and frittering away the power.

The second illustration is of a linotype machine driven by belt by a ½h.p. motor. In order to get a good pulley grip, a very neat arrangement of jockey pulley has been supplied, which is well shown in the photograph.

The Franco-British Exhibition.

THE first sod of the grounds of the Exhibition was cut on Jan. 3rd of this year by the Count H. de Manneville on behalf of the French Ambassador, in the presence of a large and distinguished company. The present advanced stage of the buildings and the general development of the extensive area testifies to the immense amount of work which is being effected at an almost incredible rate.

The site selected at Shepherd's Bush covers 140 acres. The principal entrance is immediately adjoining the station of the Central London Railway (popularly known as "the Tube"), and within four miles of Charing Cross. It is close to the Uxbridge

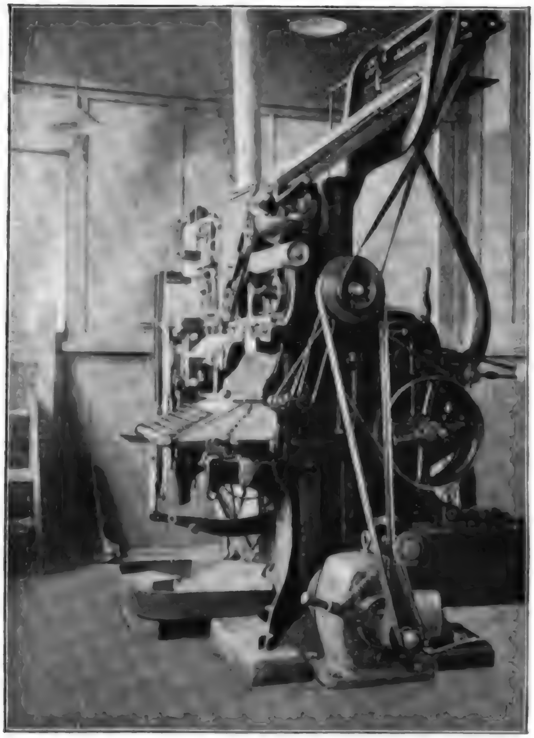


Fig. 2. Electrically Driven Linotype Machine.

therein are the liberal arts, science, chemical industries, social economy, and all descriptions of alimentation.

Extending from the Uxbridge Road entrance across the intervening space to Wood Lane, a fresh entrance as handsome as the principal one is reached by way of these buildings, and this opens almost immediately into the first of a series of courts—the Court of Honour. Flanked on either side by great palaces, the main feature of the court is the lake occupying the centre. Around this large waterway extend broad terraces, while across the centre runs a handsome bridge and here and there aquatic pavilions have been erected above the lake. At the far end is a handsome building, the Congress Hall, in which a large number of International Conferences have been arranged for, and stretching down from this into the lake is a magnificent crystal cascade of flowing water, the splendid effect of which by day will be heightened by night by an arrangement of electric lights beneath the waterfall.

The long halls extending on each side of the lake are to be devoted, one to French industries and the other to British, and in the latter will be arranged the exhibit of textiles which, it is said, will be on a scale that has never previously been seen. The Agricultural Halls—British and French—are also reached from this court, as is the Education Hall, another fine building worthy of its important object.

Passing Congress Hall the Court of Arts is gained, and around this runs a series of wide grass-banked lagoons, served by the lake already noted, and traversed at frequent intervals by bridges, while in the centre are a number of lagoons. Chief among the buildings placed in the Court of Arts are the British and French Applied Art Palaces, and for the British display the commercial leaders of Birmingham and Sheffield are combining to uphold the honour of their country against their skilled competitors. The British Applied Art Palace will, in fact, show the labours of these two great provincial cities in a way that has never hitherto been attempted outside their boundaries. To right and left respectively, the Fine Art Palace and the Palace of Decorative Arts are placed. Each is a tremendous building

Road station of the West London, London and North-Western, and Great Western Railways, and the Metropolitan, Hammersmith, and City Railway stations. It is also in close proximity to the Shepherd's Bush station of the London and South-Western Railway, and in direct connection with the District; North London; Metropolitan; London, Brighton, and South Coast; South-Eastern and Chatham; and Great Central Railways. It is, moreover, at the centre of a network of tramways and omnibus routes affording means of communication with all parts of London and the suburbs.

From the main entrance continue a series of halls leading into the grounds, and in these buildings will be housed many of the most important exhibits. Wide and lofty, they will provide an admirable place for displaying the various goods to the very best advantage, for they would have the further advantage that a considerable majority of the visitors must necessarily enter by the halls. French and British commerce will be equally divided between this portion, and the chief British sections to be found

which will compare favourably with the famous galleries of the world.

At the limit of the Court of Arts and marking its separation from the Elite Gardens, is the Imperial Tower, a commanding edifice, forming a remarkable central feature of the grounds.

The gardens themselves will be the rendezvous where every visitor will eventually and inevitably find a way for rest and enjoyment. Covering a large area, they will be laid out with trees and turf. In the centre is a band-stand with an amphitheatre all around, and on the right of this will be the Garden Club, a luxurious building standing in delightful ground. Here also will be restaurants suited for the requirements of all classes, and here will be the Royal Pavilion. Opposite the Garden Club is the Franco-British Pavilion, where the further strengthening of the entente cordiale will be typified by the joining of the building over the road.

Leaving the gardens by this route, the Court of Progress is seen. In this the Paris Municipal Pavilion will be set up, and alongside it will be similar buildings reserved for the use of visitors from the cities of Great Britain led by London. Around this Court is the largest building in the Exhibition—the Palace of Engineering or Machinery Halls, which provide a greater space for exhibits than any other hall in the Kingdom. In addition to the display made in these halls, working exhibits of machinery will be found in various parts of the grounds.

Farther on is the grand avenue of the Colonies, a magnificent roadway of horse-shoe shape, which leads to the Colonial Halls. The first is a building of 120,000 sq. ft., which the Dominion of Canada is putting up at the cost of about £65,000, and in which the many great industries of our North American daughter will be shown. Adjacent is Australia's Palace, equally large in extent: and opposite the latter is the site of a special building which the Commonwealth Government will erect; New Zealand, the Crown Colonies, and Africa are each separately represented by large areas for the display of their commerce, and Ceylon and India have done the same, the latter having received a substantial grant from the Indian Government.

The remaining half of the horseshoe will be devoted to the French Colonies, one of the most prominent features being the exhibits from Algeria.

The huge arena and stadium where the Olympic Games are to be held is next reached, and these practically speak for themselves. Besides the cycling and cinder tracks laid out by experts there is a fine swimming pond, and sufficient turf in the centre for all grass games. The tremendous stadium running right round the tracks will be capable of holding over eighty thousand people, while beneath the seats is to be arranged an international sports exhibition, for which plenty of space is allowed after providing accommodation for judges, competitors, and sightseers.

Even this does not exhaust the attractions, for a large area is left quite distinct from the commercial side, for the many entertainments and attractions indispensable in an exhibition of this character. Next year will, accordingly, be memorable for an exhibition the like of which has never been seen anywhere in the Empire, and one which will undoubtedly go down to fame as such.

International Electro-Technical Commission.

THE preliminary meeting of the above Commission was held in London in June, 1906, at which delegates from some fourteen countries were present. The Right Hon. Lord Kelvin, P.C., O.M., was elected the first president, and Colonel R. E. Crompton, C.B., honorary secretary of the Commission. A set of proposed rules relating to the general organisation of the Commission was drawn up and adopted subject to ratification by the authorities who had appointed the delegates. These rules have been practically accepted by all countries and there is, therefore, little doubt of their being finally adopted at the first meeting of the council, which, we understand, is likely to be held next summer. Broadly speaking the rules are based upon all countries being on an equal footing, with equal taxation and equal voting power; they also provide for the manner in which the recommendations are to be arrived at, and place the affairs of the Commission and the method of carrying out its objects in the hands of a representative council, consisting

of the president of the Commission and the presidents of the local committees (who are vice-presidents of the Commission *ex officio*), one delegate from each of the local committees, and the honorary secretary. The general objects of the Commission are set forth in the following resolution, adopted by the Chamber of Government Delegates at the Electrical Congress held at St. Louis in September, 1904:

"That steps should be taken to secure the co-operation of the technical societies of the world by the appointment of a representative Commission to consider the question of the standardisation of the nomenclature and ratings of electrical apparatus and machinery."

We understand that up to the present time local committees have been appointed in Austria, Belgium, Denmark, England, France, Germany, Hungary, Mexico, Sweden, and the United States; and that the question of appointing a local committee is also being considered in Australia, Canada, Japan, New Zealand, Russia, South Africa, and Switzerland.

In a movement of this nature progress must necessarily be slow, but the fact that so many countries have already appointed local committees is not only very gratifying but shows the interest taken in electrical standardisation throughout the world.

From the commencement the Institution of Electrical Engineers, Great Britain, has taken a very prominent part in the matter, and not only have they defrayed the preliminary expenses but have most generously granted a substantial loan to the Commission in order that no financial difficulties should hamper the work of organisation during the first year, which action has been much appreciated by all concerned. The success with which the movement is meeting on all sides will not, however, necessitate any great inroads being made into the funds placed at the disposal of the Honorary Secretary by the Council of the Institution.

At the end of last year the British local committee appointed a sub-committee on nomenclature, under the chairmanship of Mr. A. P. Trotter, the electrical adviser to the Board of Trade. This sub-committee is now engaged in drawing up a list of terms, with their explanations, in general use in the electrical industry, and the council of the Commission we understand will most probably publish a glossary of electro-technical terms in French and English, the languages in which it has been decided all reports of the Commission are to be published. Under nomenclature is to be included the question of symbols, which will be taken up at a future date. When the local committees in the different countries have settled down to work, the British local committee, we understand, will appoint a sub-committee on electrical machinery and apparatus to consider in particular what matters can be brought to the notice of the Commission with a view to possible international agreement. The British local committee is working in conjunction with the local committee of those countries taking part in the labours of the Commission, and the secretaries of the local committees are kept *au courant* through the medium of the central office now established in London at 28, Victoria Street, Westminster, the secretarial work being in the charge of Mr. C. le Maistre, A.M.Inst.C.E., the acting secretary to the Commission, to whom all enquiries should be addressed.

LITERARY Section.

Including

Reviews of Books, List of Practical Works, Publishers' Notices, Standard Publications, WORLD'S ELECTRICAL LITERATURE, New Catalogues, &c.

Readers will find this Section invaluable. We shall be pleased to furnish further particulars regarding the Books dealt with herein, or to supply information concerning any other books. Communications requiring an answer through the post must be addressed to Literary Editor, THE ELECTRICAL MAGAZINE, *Bazaar Buildings, Drury Lane, London, W.C., and accompanied by stamped envelope.*

Practical Coal-Mining. EDITED BY W. S. BOULTON, B.SC., F.G.S. DIVISIONAL VOLUME 3. (LONDON: THE GRESHAM PUBLISHING COMPANY, 34, SOUTHAMPTON STREET, STRAND, W.C. TO BE COMPLETED IN 6 VOLS. PRICE 6s. EACH NET.)

The third volume of this work maintains the very high standard of production and contents which has characterised the preceding numbers. The particular sections dealt with herein are haulage, winding, and pumping. The subjects are treated fully and the methods and plant described include the very latest practice. We can only repeat that the entire series is likely to become the standard work on coal-mining practice, and should consequently be acquired by everyone connected in any way with the mining industry.

The Elements of Electrical Engineering: A FIRST YEAR'S COURSE FOR STUDENTS. BY TYSON SEWELL, A.M.I.E.E. FOURTH EDITION, REVISED AND ENLARGED, WITH 277 ILLUSTRATIONS. (LONDON: CROSBY LOCKWOOD & SON, 7, STATIONERS' HALL COURT, LUDGATE HILL, E.C. PRICE 5s. NET.)

This book is already a great favourite amongst technical students, particularly those who attend the evening classes at local technical schools and polytechnics. The author is lecturer and demonstrator in electrical engineering at the Regent Street Polytechnic, London, and is consequently in the best position for providing an elementary text-book which shall be suitable for the student who is engaged in practice and has but a limited time to give to study. There is no fault to be found with the arrangement of the subject, and the manner of its treatment is such as to afford the greatest benefit to the working engineer. The book can be taken up as a standard text-book for work on the City and Guilds syllabus.

It should be noted that the principal added matter in this the fourth edition includes descriptions of the latest forms of electric lighting: flame arc lamps, Nernst, tantalum, osmium, mercury vapour, and Moore tube lamps. The subject of three-wire distribution systems has received further attention in the form of an appendix. Not the least commendable feature of an altogether useful book is its low price, which places it within the reach of all aspiring engineers and trade apprentices.

Pitman's Office Desk Book, WITH TABLES AND READY RECKONER. (LONDON: SIR ISAAC PITMAN & SONS, LTD., 1 AMEN CORNER, E. C. PRICE 2s NET.)

This little book is a collection of the data and general information which are so often required by the general clerk. The subjects are arranged in alphabetical order with each page indexed in dictionary style. It will be found of the greatest service, and a particular place should be reserved in every business office for its reception.

La Télégraphie sans Fil et la Télémécanique. PAR E. MONIER. H. DUNOD ET E. PINAT, EDITEURS. (PARIS: 49, QUAI DES GRANDS-AUGUSTINS. PRIX 2 FRANCS.)

A book describing the principles of radio-telegraphy. The work deals with the evolution of wireless telegraphy, and with the construction of the necessary apparatus for the wireless transmission and reception of electric signals.

Electric waves, and the laws concerning the propagation, length and frequency of the same, are treated in a popular style. The use of radio-telegraphy in times of peace and war, and the application of its principles to mechanical apparatus other than those employed for the usual transmission of messages, are also subjects included in a serviceable little book which is easily read and should prove interesting to layman and student alike.

Inventions, Patents and Designs. WITH NOTES AND THE FULL TEXT OF THE NEW BRITISH PATENTS AND DESIGNS ACT, 1907. BY G. CROYDON MARKS, M.P. (LONDON: THE TECHNICAL PUBLISHING COMPANY, LTD., 55 AND 56, CHANCERY LANE. PRICE 3s. 6d. NET.)

"It cannot be too readily borne in mind that invention is of international rather than national growth, and that as with science, so with manufacturing arts and industries, no country can claim a monopoly in that type of mind and intellect that originates, developes, and discovers improvements.

"Some British manufacturers have a peculiar habit of keeping the nature of their business a secret in the districts where they reside and within the social circle they cultivate. With the object of masking their actual pursuits they affect an interest in stocks and shares, or in rural and country pursuits, sports, and pastimes. Where this spirit prevails, and where neither pride or pleasure is developed in the business or industry, it is not surprising that suggestions for improvement are not appreciated, and that opportunities for betterment as to the output are ignored or not recognised.

"The sons and successors of those who founded business undertakings frequently ignore such industries, and evince neither desire nor aptitude for keeping to the front or leading with new features in the commercial race Habits of indolence lead to the rejection of proposals that are made such as would involve any alteration of plant, the scrapping of old machines, and the adoption of more modern methods for meeting in an economical manner the newer demands of fresh markets, and consequently other foreign competitors are encouraged to embark against them.

"That it should be possible to thus condemn many British manufacturers for driving trade away from this country is an appalling commentary upon one of our weak national traits of self-confidence and insular narrowness."

The above are abstracts from the author's introduction to this book. Whether the average British manufacturer deserves the complaint so strongly expressed is open to criticism but will not be discussed at this writing. It is quoted merely as showing that the object of the author is apparently not merely to explain the mysteries of the patent law and procedure, but that he is bent upon encouraging all and everybody to seek "Letters Patent." Generally speaking it may be accepted that the British manufacturer and designer is pretty wide awake as to the value of a discovery or new design, even if he may be "indolent" in other ways, and is not slow to legally protect the right thing.

The book itself consists ot some one hundred and odd pages, about half of which are given up to a reprint of the Act of 1907. The other half contains eleven chapters dealing respectively with the meaning of "Patent": What is patentable?; opposition to patent; surrender and revocation of patent; licensing and invention; infringements of patents; working in England; threatening legal proceedings; applying for injunction; how to work a patent; and designs. It will thus be seen that the work is practically a small treatise for the guidance of those who contemplate the protection by patent of inventions, or who having secured patents desire to know how to handle them to the best advantage.

Notes on the Construction and Working of Pumps. BY EDWARD C. R. MARKS, A.M.I.C.E., M I.M.E., &c. SECOND AND ENLARGED EDITION. (LONDON: THE TECHNICAL PUBLISHING COMPANY, LTD., 55 AND 56, CHANCERY LANE. PRICE 4s. 6d. NET.)

This book covers its subject thoroughly and entirely. The theory and design of every type of pump is considered and the leading makers' patterns are fully described. In this, the second edition of a work originally published only five years ago, the author has brought his subject quite up to date, having included particulars of the present-day development of high lift centrifugal and turbine pumps. An appendix giving the subject and date of Patents relating to centrifugal and turbine pumps will be found useful as a reference by those engaged in the engineering work of pump design.

Electric Power and Traction. By F. H. DAVIES, A.M.I.E.E. (LONDON: ARCHIBALD CONSTABLE & CO., LTD., 10, ORANGE STREET, LEICESTER SQUARE, W.C. PRICE 6s. NET.)

The author set himself the task of assembling in one volume all that electrical information which will meet the requirements of those engaged in the principal industries into which the electric motor enters as the power unit. He has done his work well. Presuming practically no knowledge of technical electricity, but merely that which is acquired by every man through general reading and observation, the book glides quickly and easily into electrical power practice. The great merit of this work is indeed the clever way in which the author is able to express fundamental principles in a popular yet altogether true form and without wasting time in doing so.

The first four chapters are devoted to the Generation and Distribution of Power. The several present-day systems are described fully, and the reasons for the selection of each to best

suit the requirements of district and service are gone into. The principles of power plant design and arrangement and the working control of central stations, direct current and alternating current, receive full attention. The fourth chapter develops the subject of generation and distribution to a consideration of such final phases as the relation of output to the cost of production; economy of power schemes; comparative costs of overhead and underground transmissions; wood and steel poles for transmission lines; and even to the very modern stage of a statement as to the maximum pressure for which an underground cable can be designed, citing the particulars of the 100,000-volt cable shown at the recent Milan Exhibition.

The electric motor next receives similar thorough attention. The operating principles of series shunt and compound motors are described; their peculiarities and suitability for various duties are indicated; and their control and possibilities are fully discussed. The same critically complete treatment is accorded to alternate-current motors—polyphase and single-phase of all types.

Succeeding chapters are given up to the use of electric motors in specific industries: collieries, engineering workshops, textile factories, printing works, at sea and on canals.

Here the book divides as suggested by its title, the remaining ten chapters referring entirely to electric traction. It will suffice to say that separate treatment at chapter length is accorded to the overhead system and trackwork; the conduit system; the surface-conduit system; and to car building and equipment. The present importance of electric railways has been recognised to the extent of the five concluding chapters of a book containing nearly 300 pages. The comparison of the direct-current and alternate-current railway systems is particularly interesting. Quoting the author in his description of the London, Brighton and South Coast electric traction scheme now under construction: "The question of single-phase versus other forms of electric traction was most thoroughly gone into by the company's directors and Mr. Philip Dawson, their engineer, and the result was an unqualified approval of the former. Upon the strength of this the company have committed themselves to a scheme which can by no means be looked upon as an experiment, and although this course is perhaps open to criticism upon the score of its apparently daring nature, there is no doubt in the minds of those duly qualified by experience to know, that the company have made a wise and enterprising decision."

The glossary of electrical terms most often met with in general practice and an index to the contents form a praiseworthy conclusion to an altogether useful work.

India-rubber and its Manufacture. WITH CHAPTERS ON GUTTA-PERCHA AND BALATA. BY HUBERT L. TERRY, F.I.C. (LONDON: ARCHIBALD CONSTABLE & CO., LTD., 10, ORANGE STREET, LEICESTER SQUARE, W.C. PRICE 6s. NET.)

There is decidedly a demand for a book of this description. The ever-increasing use of rubber and the efforts made of recent years to systematise and promote its production have led to a very wide general interest being taken in the subject. Rubber schemes have been the theme of several recent company prospectuses, and the question of developing some of the remote and less valuable of our Colonies into gold mines as rubber-tree plantations has fired public interest.

Rubber, like leather, is one of those natural products which defy the efforts of chemist and manufacturer to devise a real substitute or artificial duplicate. At least, that is true in the commercial sense, for although caoutchouc has been made in the chemist's laboratory, the process is so far merely of theoretical interest, and no practical outcome has resulted. There is in the subject of this book much that can be depended upon to appeal to the general reader, the description of the unusual primitive native methods of extracting the latex or sap from the bark of trees and reducing it to marketable bulk and form, working in tropical forests, lending some charm to a treatise of this description.

The book contains some three hundred pages and covers a great deal of ground. Starting with a historical and general survey, the author passes on to the natural sources of rubber. The botanical features of the several species of trees affording the supply, the methods of tapping the bark and the subsequent drying off or reduction of the liquid sap to the solid, elastic state of rubber as imported into this country are in turn dealt with. The various brands of imported rubber are compared.

The third chapter introduces the consideration of the chemical and physical properties and leads up to the wide subject of vulcanisation.

The author returns to the origin of rubber and devotes the fifth chapter to india-rubber plantations, having particular reference to the studied cultivation of the trees. It seems that so far back as 1872 the British Government interested itself in this matter, for in that year the India Office instructed a botanist to report to them as to the rubber trees of America, and in 1875 experts were sent to Panama and Para to gather information and seeds and cuttings. The question of acclimatising rubber-yielding trees brings the author to a consideration of the commercial possibilities of rubber plantation companies. Quoting from his opinion on this score:

> "This is a point on which it is almost impossible to speak with precision, and

the author . . . will limit himself to the more cautious step of pointing out the main factors which must be taken into consideration.

"The remarkable increase in demand witnessed in recent years will continue. . . . The output from America and Africa will not show a corresponding rate of increase, although the increase may be expected to be steady and maintained.

"The present high price is due not to any indications of exhaustion in the crop, but to the inter-actions of the ordinary laws of supply and demand.

"Far from South America showing signs of depletion there are vast quantities of rubber trees in Bolivia, Peru, and Colombia, which are at present untapped owing to scarcity of labour and lack of transport facilities.

"The future for the plantations . . . depends a good deal upon the utilization or non-utilization of the latent stores of rubber . . . in South America."

In dealing further with this aspect of the rubber industry, the author cites the low cost of production by planters as signifying their ability to view considerable falls in price with equanimity.

Successive chapters are given up to rubber substitutes and reclaimed rubber. From then onwards the practical treatment and commercial working of the crude product into finished articles is dealt with. The manufacturing processes are treated at length. The preparation of sheet rubber and its subsequent formation into finished articles occupies Chapter XII. The range of products afterwards described as in manufacture is a very wide one, including mechanical goods, golf balls, foot-wear, waterproofs, tyres, bottles, wires and cables, vulcanite, and so on. The two following chapters deal with the commercial handling of rubber goods: contracts for india-rubber goods, and the testing of rubber goods. The concluding two chapters are devoted respectively to a general description of the origin and properties of gutta-percha and balata.

In general it can be said that the book is one of exceptional interest and undoubted value. The author has treated his subject thoroughly and at the same time has produced a well-written work, full of information which will be found of use by almost every reader. The publisher's part of the work calls for commendation also: the printing is of the highest class and the general get-up of the book will please the most fastidious.

It should be mentioned that this book is one of a line named the "Westminster Series," of which the publishers announce nineteen others and more to follow. The object of this series is to present technical subjects in such form as can be readily understood by and tend to the entertainment of the general reader. At the same time the books are written by experts in each particular sphere of industry covered, and the contents can be accepted as absolutely reliable and not merely garbled accounts moulded to suit the public palate.

BOOKS RECEIVED.

Modern Steam Traps (ENGLISH AND AMERICAN): THEIR CONSTRUCTION AND WORKING. BY GORDON STEWART. (MANCHESTER: THE TECHNICAL PUBLISHING COMPANY, LTD., 287, DEANSGATE. PRICE 4s. 6d. NET.)

The "Mechanical World" Pocket Diary and Year Book for 1908. CONTAINING A COLLECTION OF USEFUL ENGINEERING NOTES, RULES, TABLES AND DATA. (MANCHESTER: EMMOTT & CO., LTD., 65, KING STREET. PRICE 6d. NET.)

The "Practical Engineer" Pocket Book and Diary, 1908. (MANCHESTER: THE TECHNICAL PUBLISHING COMPANY, LTD., 287, DEANSGATE. PRICE, CLOTH 1s.; LEATHER GILT WITH DIARY, POCKET AND ELASTIC BAND, 1s. 6d. NET.)

Die Elektrochemische und Elektrometallurgische Industrie Grossbritanniens. BY JOHN B. C. KERSHAW. TRANSLATED INTO GERMAN BY DR. MAX HUTH. WITH 87 ILLUSTRATIONS, 10 TABLES AND APPENDIX. (HALLE-A-S.: WILHELM KNAPP. PRICE 9 MARKS.)

Handbuch für den Bau und die Instandhaltung der Oberleitungsanlagen Elektrischer Bahnen. BY ARTHUR ERTEL. WITH 294 ILLUSTRATIONS, 2 TABLES AND DIARY. (HANNOVER: DR. MAX JÄNECKE. PRICE 5 MARKS.)

Liquid and Gaseous Fuels, AND THE PART THEY PLAY IN MODERN POWER PRODUCTION. BY VIVIAN B. LEWES, F.I.C., F.C.S., &C. (LONDON: ARCHIBALD CONSTABLE & CO., LTD., 10, ORANGE STREET, LEICESTER SQUARE, W.C. PRICE 6s. NET.)

Town Gas and its Uses FOR THE PRODUCTION OF LIGHT, HEAT, AND MOTIVE POWER. BY WILLIAM HOSGOOD YOUNG WEBBER, C.E. (LONDON: ARCHIBALD CONSTABLE & CO., LTD., 10, ORANGE STREET, LEICESTER SQUARE, W.C. PRICE 6s. NET.)

New Catalogues.

Flame Arc Lamps.—JOHNSON & PHILLIPS, LTD.—We have received price-lists of two types of flame arc lamps from Messrs. Johnson & Phillips. The first list, No. 40, gives details of the type known as the Magnet-Juno flame lamp. In this lamp the carbons converge, and the particular feature is the general simplicity of the interior parts. The second list, No. 41, gives an illustrated description and prices of a new type of flame lamp, having vertical carbons. The lamp is claimed to have a very high efficiency, and gives a light of a pale yellow colour. They are made for low-current consumptions, from three amperes upwards, and are arranged for four or five lamps being connected in series on 200-220 volts. It should be noted that in this list the offer is made, to any responsible prospective purchaser, of two weeks' free trial of the lamp.

Switch-gear.—UNION ELECTRIC CO., LTD.—List No. 6011 illustrates and describes a line of main switches for medium and heavy currents suitable for low-tension circuits. The switches are built for assembling either on the front or back of the switch-board panel. Particular attention is directed to the type C switch, which is fitted with a magnetic blow-out attachment, as well as with the usual auxiliary sparking tips. The switches are designed on the unit principle, so that they can be readily adapted for use as single, double, or three-pole.

Machine Tools.—EDWARD G. HERBERT, LTD., send us an interesting catalogue of small machine tools and accessories. The tools include several designs of sawing machines, some of which are self-contained with an electric motor drive. Some of the saws are of the eccentric type, others are power-hack-saws. A line of circular sawing machines and others with disc cutters are also illustrated. Of the accessories included are centring tools, file-testing machines, drill starters, cramps, belt-fasteners, &c.

Electric Pulley Blocks.—S. H. HEYWOOD & CO., LTD.—An illustrated folder giving specification and dimensions of a line of chain-type electric pulley blocks. These pulley blocks are made in sizes suitable for weights of half-ton up to four tons, and for lifting speeds of 16ft. to 8ft. per minute.

"Electrical Mining."—THE GOODMAN MANUFACTURING COMPANY, LTD.—This is the title of a monthly publication issued by the Goodman Company. The November number gives some very interesting and well-illustrated details of a noteworthy electric mining installation in West Virginia. Another notable article is one dealing with the operation and care of electric locomotives.

Glow Lamps.—BRYANT TRADING SYNDICATE, LTD.—A folded card illustrating the several types of Royal glow lamp supplied by this firm.

Bells, Indicators, &c.—THE SUN ELECTRICAL COMPANY, LTD.—Catalogue No. 157, Section B, is a very complete illustrated price-list of an extensive line of electric bells, indicators, pushes, fire alarms, wiremen's tools, small instruments, and the accessories and implements required by electricians and wiremen generally.

Surface Condensers.—WILLANS & ROBINSON, LTD.—This is a handsome publication describing the surface condensing plant, air pumps, and details of equipment as manufactured by this well-known firm. Included with same is a list of customers for this plant, which is very lengthy, and indicates that Messrs. Willans & Robinson are doing good business in this direction.

Educational.—THE BRITISH CORRESPONDENCE SCHOOL OF ELECTRICAL ENGINEERING.—The syllabus of the correspondence classes of this institute gives particulars of the range of subjects covered by the lessons and the corresponding fees. The technical directors of the institute are Mr. Frank Broadbent, M.I.E.E., and Mr. Andrew Stewart, A.M.I.E.E.

Trade Notices.

An Underground Electric Tempering Furnace.—THE ELECTRICAL COMPANY, LTD., London, W.C.—There has been acquired for the Village Deep Mine of the Rand one of this company's electric annealing or hardening furnaces for underground use in drill tempering. Should it prove successful the direct economies emanating from its general use will be considerable, as it will overcome the difficulties of over-heating and burning the steel, and obviate the expense, labour and delay of carrying the drills to the surface every time they require sharpening. The initial tests, according to *South African Mines*, are being carried out at the surface, and subsequently lengthy and rigid tests will be made underground, and if the results come up to expectations then one furnace will be supplied to every three levels. This furnace, if the result expected is realized, will have a far-reaching effect as an important working factor in Rand working costs. Several managers have given the information that they now use steel of a medium quality in preference to the best steel, for the reason that under the present system of tempering, the best steel is often burnt and is invariably reduced to the quality of poorer steels. The latter, on the other hand, are found to suffer no corresponding falling off in quality. This practice, which is by no means general, may largely account for the complaints made regarding faulty steels. Should this furnace prove the success indicated then the best steel only would be used, with the consequent result that fewer complaints will be made about the blunting of the drills at the first go off. Poor workmen complain of bad tools, but even good workmen cannot make good progress with bad tools.

The surest way to spoil good workmen is to give them bad tools, and much more attention ought to be given to the important questions of tempering and sharpening drills, not on the Rand Mines only but also in all other mining fields. A complete description of the electric furnace in question appeared in THE ELECTRICAL MAGAZINE of October, 1906.

New Agency.—BAXTER & CAUNTER, 86, Charing Cross Road, W.C., advise us that they have relinquished the agency of the Perfecta Seamless Steel Tube and Conduit Company, and have taken up the sole agency for the Credenda Conduits Company of Birmingham for London and the South and East Coasts. They are to hold a large stock of conduits at their London warehouse and will consequently be in a position to meet prompt demands.

Amalgamation.—The amalgamation is announced of the engineering firms Applebys, Limited, and the Temperley Transporter Company. These firms are well known as manufacturers of cranes and transporting machinery of every description, specializing in shipyard, dock, and harbour equipments, steel works, coal-handling and contractors' plant. The amalgamated firms will trade under the title of Applebys, Limited, with offices at 58, Victoria Street, Westminster, and works at Glasgow and Leicester.

T. W. Broadbent, Ltd.—This company has been formed in order to acquire and take over the old-established electrical engineering business carried on by Mr. T. W. Broadbent at the Victoria Electrical Works, East Parade, Huddersfield. The capital of the Company is £5000 (440 5 per cent. cumulative preference shares of £5 each, fully paid, and 560 ordinary shares of £5 each, fully paid), the whole of which has been privately subscribed. The subscribers are T. W. Broadbent, Hillside House, Kirkheaton, near Huddersfield, electrical engineer; G. A. Broadbent, 33, Cleveland Road, Huddersfield, land surveyor; F. W. Davies, 35, Newsome Road, Huddersfield, electrical engineer; R. Broadbent, Walden, Kirkheaton, near Huddersfield, secretary; J. Broadbent, Kirkfield House, Kirkheaton, near Huddersfield, assistant superintendent, Post Office; J. E. Broadbent, 64, Dunford Road, Holmfirth, secretary; Mrs. T. W. Broadbent, Hillside House, Kirkheaton, near Huddersfield. The first directors (of whom there are not to be less than two or more than five) are T. W. Broadbent, G. A. Broadbent, and F. W. Davies. Directors' qualification, £100 in ordinary shares.

The trend of electrical development being continually towards new and more efficient means of electrical driving, and the three-phase system, which a few years ago was in use in only a few large installations, coming more and more into favour, it has been thought desirable that this class of work should be given special prominence; and the above company has been formed with a view to taking up the manufacture of three-phase motors and starters on a larger scale. As heretofore, the manufacture of the well-known D type dynamos and M type motors, the N type and R type single-phase motors, and other of T. W. Broadbent's specialities, will still be carried on.

Monte-Callow & Co.—We are advised that Mr. Monte-Callow has given up business at Ipswich and joined the firm of Marples, Leach & Co, of Bishopgate Street Without, who will continue to deal in the well-known Monte-Callow specialities in addition to their own dynamos, motors, fans, and general accessories.

Contracts Received.—MIRRLEES WATSON CO., LTD., advise that they have recently received orders for a number of condensing plants, amongst which are the following:—

City of Glasgow Tramways Department: Surface condensing plant dealing with 50,000lb. steam per hour, for 28½in. vacuum. The plant will be working in connection with a Richardson Westgarth steam turbine.

Gloucester Railway Carriage and Wagon Company, Ltd.: Surface condensing plant for working with steam turbine, dealing with 10,000lb. steam per hour; 28in. vacuum.

Bolckow, Vaughan & Co, Middlesbrough: Surface plant dealing with 43,000lb. steam per hour, working in connection with blowing engines.

Martin Bros., Valparaiso: Surface plant dealing with 15,000lb. steam per hour.

Chinameca Sugar Estate, Mexico: Two barometric jet condensers with dry air pumps, 8000lb. steam per hour.

City of Glasgow Tramways Department: Two sets of motor-driven boiler feed pumps.

Fraser & Chalmers, Ltd.: One set of surface condensing plant working with steam turbine.

LANCASTER & TONGE, Ltd., advise us that the well-known Lancaster steam traps were supplied in connection with the equipment of the ss. "Lusitania" and "Mauretania."

WILLANS & ROBINSON, LTD. The Huddersfield Corporation have just placed a contract in the hands of Messrs. Willans & Robinson, Ltd., of Rugby, for two 2500k.v.a. turbo-alternators, the plant being required in the early spring of next year for supplying electric power to certain textile mills in the neighbourhood who have decided to adopt electric motor driving.

In view of the importance of giving an uninterrupted supply of energy to these mills the Corporation decided after inspecting various turbine stations in this country to instal what they found on enquiries to be the most reliable plant obtainable, and the turbines selected were ordered primarily in consideration of this factor.

You should carefully study this page, as it will save you much valuable time. It is the key to the World's Monthly Electric Progress. We can supply the publications mentioned, or any article indexed, for a small fee. In writing us, enclose stamped P.C. for reply.

Power.

The Thury Direct-current Transmission System. D. Kos.	*Elec. World,* 26/10/07.
Electric Charging Plant for Blast Furnaces. G. Meyer.	*Elek. Kraft u. Bahn.,* 3/8/07
Electric Winding in Mines. L. Becker.	*Elek. Kraft u. Bahn.,* 4/9/07.
High Tension Condensers. J. Schmidt.	*Elec. Anz.,* 8/9/07
Unbalanced Loads in Two-phase to Three-phase Transformation. B. F. Jakobsen.	*Elec. World,* 12/10/07.
Care and Operation of Electric Cranes for Blast Furnaces. A. B. Weeks.	*Mech. Wld.,* 8/11/07.
Circuit-Interrupting Devices. F. W. Harris.	*Elec. Journal,* Nov./07.
Hot Bearings: their causes and the means of avoiding them. E. Kistinger.	*Machinery,* Nov./07.
Power Required for Cranes and Hoists. U. Peters.	*Machinery,* Nov./07.
The Action of Roller Lightning Arresters.	*Elec. Eng.,* 8/11/07.

Traction and Transport.

Train Lighting Dynamo. M. Osnos.	*Elek. Zeit.,* 19/9/07.
Three-phase Locomotives. G. Jacoby.	*Elek. Kraft u. Bahn.,* 14/9/07.
Electric Railway on German-French Frontier. A. Gradenwitz.	*Elec. Rev., N.Y.,* 26/10/07.
U.S.A. and Canadian Street and Elevated Railway Statistics.	*Str. Rly. Journal,* 7/9/07.
Portable Substation for Rochester and Sodus Bay Railway. B. C. Amesbury.	*Str. Rly. Journal,* 2/11/07.
Handling Traffic at a State Fair.	*Str. Rly. Journal,* 2/11/07.
Philadelphia and Western Railroad's Automatic Electric Block Signal System.	*Str. Rly. Journal,* 2/11/07.
Some Features of the Rebuilding of Chicago's Street Railways.	*Westn. Electn.,* 2/11/07.
Maintenance of Automatic Block Signals.	*Rly. Gaz.,* 15/11/07.

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Operation of Alternators in Parallel. F. Emde.	*Elek. u. Masch.,* 22/9/07.
Superheated Steam. O. H. Wildt.	*L'Ind. Elec.,* 10/9/07.
A Graphic Calculator for Finding Power Factor Improvement by Use of Synchronous Motors. C. I. Young.	*Elec. Journal,* Nov./07.
Electrically Operated Switchboards. B. P. Rowe.	*Elec. Journal,* Nov./07.
Modern Large Power Gas Engines.	*Gas & Oil Power,* 15/11/07.
Gas Engine Efficiency. B. Hopkinson (Inst. Mech. Engrs.).	*Gas & Oil Power.* 15/11/07.

Lighting and Heating.

The Quartz Lamp *versus* Arc Lamps. A. Bussmann.	*Elek. Zeit.,* 19/9/07.
Searchlights for the Mercantile Marine. A. Gradenwitz.	*Westn. Electn.,* 19/10/07.
Efficiency of Lamps. H. Lux.	*Zeit. f. Beleucht,* 10/8/07 to 30/9/07.
Metallic Flame-Arc Lamp. C. E. Stephens.	*Elec. Journal,* Oct./07.
Metallic Filament Lamps.	*Elec. Engin.,* 10/10/07.
Electricity Applied to Stage Lighting. J. H. Kliegl.	*Elec. Rev., N.Y.,* 16/11/07.
The Electric Arc between Metallic Electrodes. W. G. Cady and H. D. Arnold.	*Amer. Jour. of Science,* Nov./07.

Telegraphy and Telephony.

Wireless Telegraphy. C. A. Culver.	*Phys. Rev.,* Sept./07.
Wireless Telegraphy. C. R. Fountain and F. C. Blake.	*Phys. Rev.,* Oct./07
Electric Oscillations. K. E. F. Schmidt.	*Phys. Zeit.,* 1/10/07.
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Poulsen Telegraphone. E. Hytten.	*Elek. Zeit.,* 5/9/07.
Detroit Telephone System. J. B. Boylan.	*Teleph., Nov./07.*
Selection of Exchange Equipment. H. P. Clausen.	*Teleph., Nov./07.*
Review of Telephone Development during Past Twenty Years. S. G. McMeen.	*Teleph., Nov./07.*

Design and Manufacturing.

New Type of Variable Speed Motor.	*Machinery,* Nov./07.
Compensated Single-Phase Shunt Motor. J. Bethenod.	*L'Ecl. Elec.,* 3/8/07.
Armature Winding for A.C. Machines.	*Elek. Zeit.,* 1/8/07.
Efficiency and Voltage Drop.	*Elek. u. Masch.* 1/9/07.
Enamel Wire. R. Apt.	*Elek. Zeit.,* 10/10/07.
Production of Alternating-Currents of any Frequency. R. Ruedenberg.	*Phys. Zeit.,* 15/10/07.

Electro-Chemistry, &c.

The Measurement of Electrolytic Resistance. W. S. Franklin and L. A. Freudenberger.	*Phys. Rev.,* Oct./07.
Capacity and Power-factor of Condensers. F. W. Grover.	*Bull Bureau of Standards,* Aug./07.
Ionization by Spraying. A. S. Eve.	*Phil. Mag.,* Sept./07
Ether. Lord Kelvin.	*Phil. Mag.,* Sept./07.
Rays of Positive Electricity. J. J. Thomson.	*Phil. Mag.,* Sept./07.
Electric Purification of Water. H. Leffmann.	*Jour. Frank. Inst.,* Aug./07.
Practical Wood Preservation. E. F. Hartmann.	*Str. Rly. Journal,* 2/11/07.

Students.

Technically Trained Men for Electric Railway Service. H. H. Norris.	*Elec. World,* 26/10/07.
The Testing of Direct-Current Dynamos C. F. Guilbert.	*L'Ecl. Elec.,* 7/9/07.
Opportunity. W. C. Kerr.	*Elec. Jnl., Nov./07.*
Induction Motors. C. Sylvester.	*Electy., 15/11/07.*

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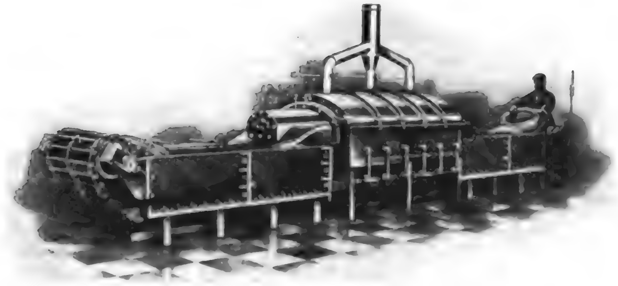

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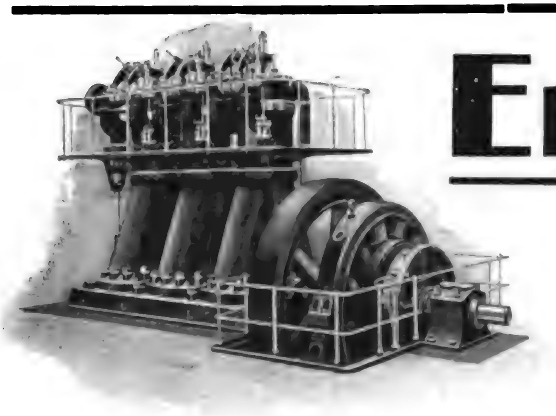

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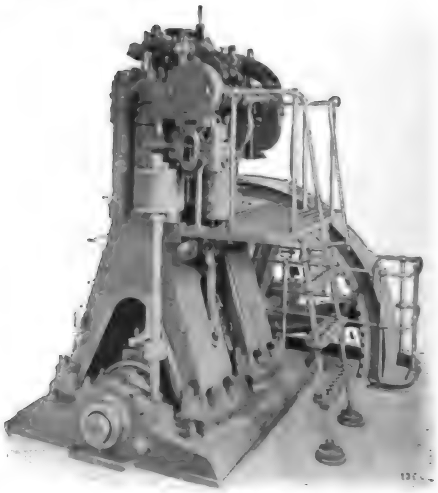

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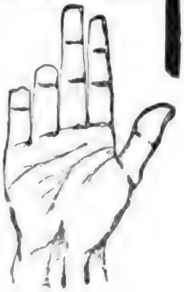

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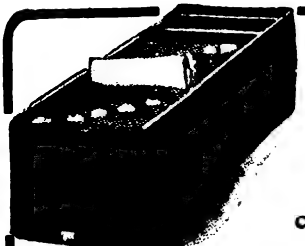

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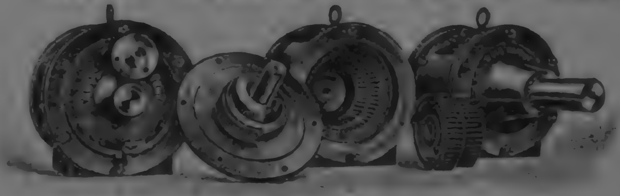

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